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日本整形外科スポーツ医学会

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1992年10月より適用
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雑 誌 の 刊 行

1. 年4回発行する。
2. 内1回は学会抄録号とし、年1回の学術集会の際に発行する。
3. ほかの3回のうち1回を英文号とし、原則として学会発表論文を掲載する。
   ほかに自由投稿論文（論述、総説）なども掲載する。

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例えば

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Kavanagh BF et al : Charnley total hip arthroplasty with cement. J Bone Joint Surg, 71−A : 1496−1503, 1989.

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例えば

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■原稿送り先
日本整形外科スポーツ医学会 事務局
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有限会社 ヒズ・ブレイン 内
TEL 03-3401-6511/FAX 03-3401-6526

Chronic Ulnar Wrist Pain from Sports Activities : Arthroscopic Diagnosis and Treatment

手関節鏡で診断・治療可能であったスポーツ選手の手関節尺側痛の検討

Shinji Nishikawa 西川 真史[1)]
Kohichi Arai 新井 弘一[1)]
Hitoshi Miura 三浦 一志[2)]
Harutaka Aizawa 相澤 治孝[1)]
Kazuhiro Sasaki 佐々木和広[1)]

●Key words
Wrist arthroscopy : Sports injury : Triangular fibrocartilage complex
手関節鏡，スポーツ障害，三角線維軟骨複合体

●Abstract

Eleven cases of chronic ulnar wrist pain from sports activity have been investigated using arthroscopy. Each case complained of tenderness and stress pain in the triangular fibrocartilage complex(TFCC), but showed no abnormal findings on X-ray or MRI. In each of these cases, the pain was not improved by conservative therapy.

Arthroscopic findings showed TFCC valvular impingement on the attachment to the carpal bone. After partial resection of the TFCC, the symptoms disappeared within 2 to 3 weeks.

The TFCC is attached to the carpal side to various extent. From these arthroscopic findings, we concluded that athletic activity in these cases exerted stress on the wrist joint and injured the TFCC that was widely attached to the carpal bone.

●要旨

目的と方法：手関節尺側TFCC部に圧痛とTFCCストレス痛を認めるが，単純写真や関節造影やMRIで異常を認めず，保存療法で症状が改善しないスポーツ慢性11症例に手関節鏡視を行った。

結果：全例TFCC円板部(以下TFC)には異常を認めず，TFCC尺側手根骨付着部を基部として月状骨関節面に弁状の軟部組織の挟まり込みを認め，これを鏡視下に切除した。術後，全例が早期に症状消失しスポーツに復帰した。切除した組織は線維軟骨であった。

結語：TFCCは尺側手根骨付着部にバリエーションが存在する可能性があり，手にストレスが多くかかる競技によっては同部に損傷を起こす可能性がある。

西川真史
〒035-0071 むつ市小川町1-2-8
むつ総合病院整形外科
TEL 0175-22-2111/FAX 0175-22-9842

1) Department of Orthopaedics, Mutsu General Hospital
2) Nakamura Orthopedic Hospital

Introduction

Chronic ulnar wrist pain associated with sporting activity often develops gragually without any specific trauma. We have examined eleven cases that could be diagnosed and treated with arthroscopic surgery. These cases are presented here, with some discussion.

Materials and methods

Eleven patients (9 males and 2 females, mean age 18.9 years, range 11–28 years) were examined for wrist pain, involving 12 joints (5 right and 7 left wrists) attributed. All suffered from chronic wrist pain to athletic activity. Four were able to trace the condition to specific traumatic incident, such as sprain or contusion from skiing, baseball or table tennis, while the remaining 7 suffered from a condition suspected to have developed through repetitive activities : one in each of gymnastics, kendo (Japanese fencing), baseball, swimming, rowing, tennis, and volleyball. Each presented severe symptoms that consisted of wrist pain associated with motion tenderness in the triangular fibrocartilage complex (TFCC) at the ulnar side of the wrist with a loss in grip strength. Some experienced severe pain that prevented them from carrying heavy objects at maximum supination of the forearm. During the clinical examination, the TFCC stress test produced a positive response, but the TFCC appeared normal on a plain radiogram and on a arthrogram (Table 1).

Table 1 Clinical deta on the patients

Case	Gender Age	Injured Side	Traumatic Incident	Sort of Sports
1	M,17	L	Re.(↑)	Gymnastics
2	F,28	L	Sp.(↕)	Skiing
3	M,23	L	Sp.	Baseball
4	M,25	L	Sp.	Boxing
5	M,25	R	Re.	Kendo
6	M,17	R	Re.	Baseball
		L	Re.	Baseball
7	M,13	R	Sp.	Table tennis
8	M,17	L	Re.	Swimming
9	M,17	R	Re.	Rowing
10	M,17	L	Re.	Tennis
11	F,11	R	Re	Volleyball

(↑) :Re.; Repetitive activity

(↕) :Sp.; Sprain

These eleven patients were treated conservatively with the use of antiinflammatories, the use of local compression bandage, and limitation of sports activities for 2 months with no improvement in symptoms. Therefore, they underwent arthroscopy with conduction anesthesia.

For postoperative care, a compression bandage was applied to the wound for several days. The patient was instructed to move the operated site freely as the pain eased. No special rehabilitative measures were applied.

Results

The arthroscopic examination indicated no abnormality in the disc proper of the triangular fibrocartilage (TFC), but the synovium had proliferated at the ulnar side. During synovectomy it was found that valvular soft tissue from the attachment of the carpal bone at the TFCC ulnar side had been entrapped on the articular surface of the lunate. The valvular soft tissue was raised with radio-ulnar deviation at the wrist joint. This soft tissue, together with the proliferating synovium, was excised using a shaver and a punch. Following the excision, a cartilaginous defect was noted at the triquetrum and ulnar side of the lunate. The tissue that had been removed was composed of fibrous cartilage.

The symptoms gradually disappeared over 2 to 3 weeks following surgery. The patients were allowed to resume athletic activities, depending on the state of their individual postoperative recovery, but usually at 2 to 3 months after surgery.

Case presentation

Case 1 : This case is a 13-year-old male. The right wrist was sprained during a game of table tennis resulting in pain when the forearm was rotated. A TFCC injury was suspected but no abnormality was recognized from arthrography. Because the pain persisted the patient underwent arthroscopy. A TFCC tear at the carpal attachment and entrapment by the carpal bone was found. The lesion was excised and the symptoms disappeared about one week after surgery (Fig. 1).

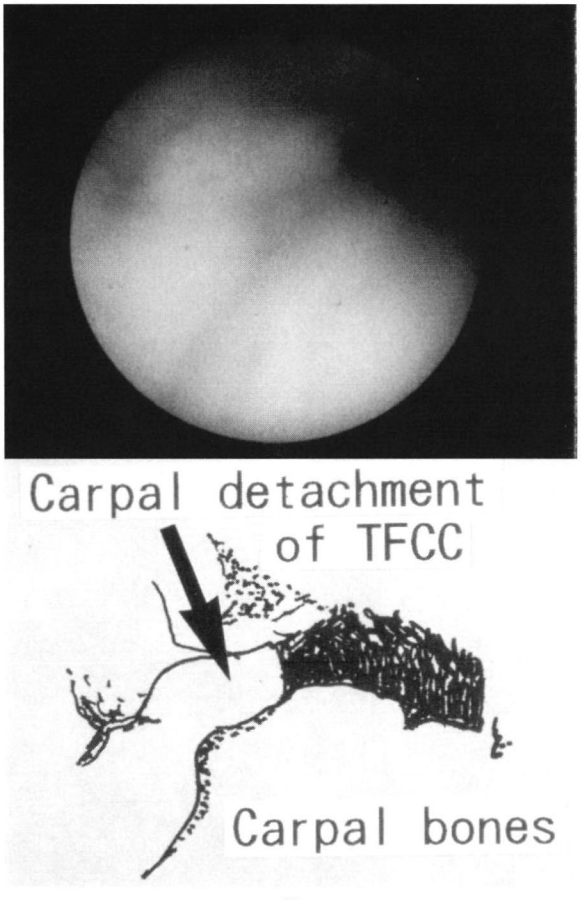
Case 2 : This case is a 16-year-old male. Pain in the left wrist was developed experienced during practice sessions of tennis. Arthrography detected no abnormality. Because the pain persisted the patient underwent arthroscopy. A TFCC tear at the carpal attachment and entrapment by the carpal bone were found. Following partial excision of the TFCC, the patient became symptom-free at 4 weeks after surgery (Fig. 2).

Case 3 : This case is a 17-year-old male. Pain in the right wrist was experienced in the ulnar side during rowing practice. Because the pain persisted the patient underwent an arthroscopy. A tear in the TFCC at the attachment and entrapment by the bone were found. Following partial excision of the TFCC the patient became free of pain within 4 weeks of surgery (Fig. 3).

Discussion

Wrist arthroscopy was employed for the diagnosis and treatment of TFCC injuries. It is suitable for the treatment of typical TFCC injuries. Among patients who engage in active sports, this procedure is particularly effective because it limits the area of surgical invasion and shortens the period required for rehabilitation. Clinical findings and arthrographic examination are important for most TFCC injuries. When an abnormality is found by arthrography, arthroscopic

A



B

Fig. 1 A 13-year-old-male.
The right wrist was spraing during a game of table tennis.
A : Arthrogram showing no leakage of cotrast material from the radicarpal space to the distal radioulnar space.
B : Arthroscopic picture showing a ulnocarpal detachment of TFCC.

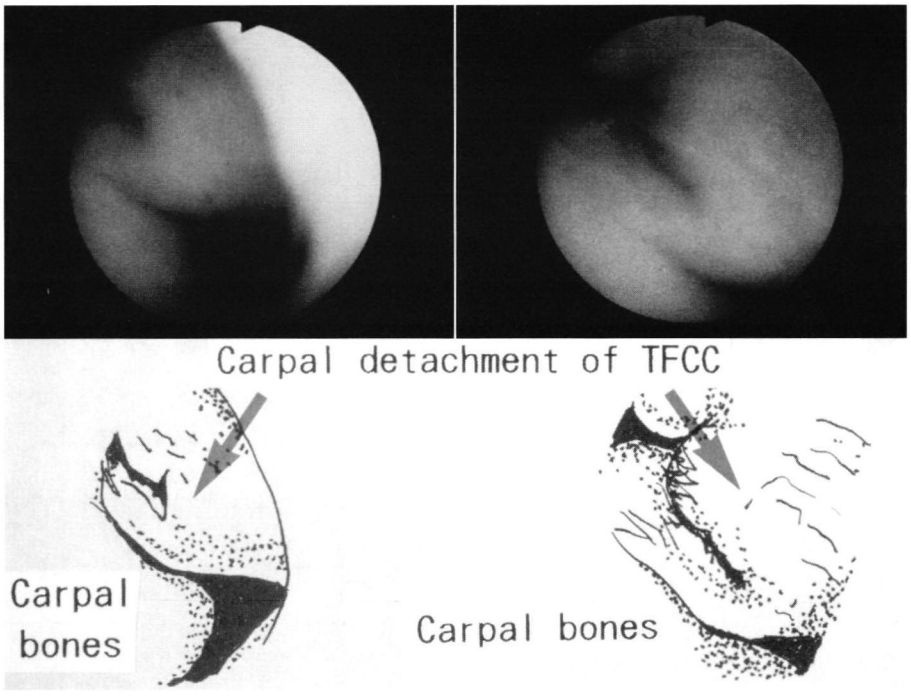


Fig. 2 A 17−year−old male.
Pain in the left wrist developed during practice sessions of tennis. Arthroscopic picture showing a ulnocarpal detachment of TFCC.

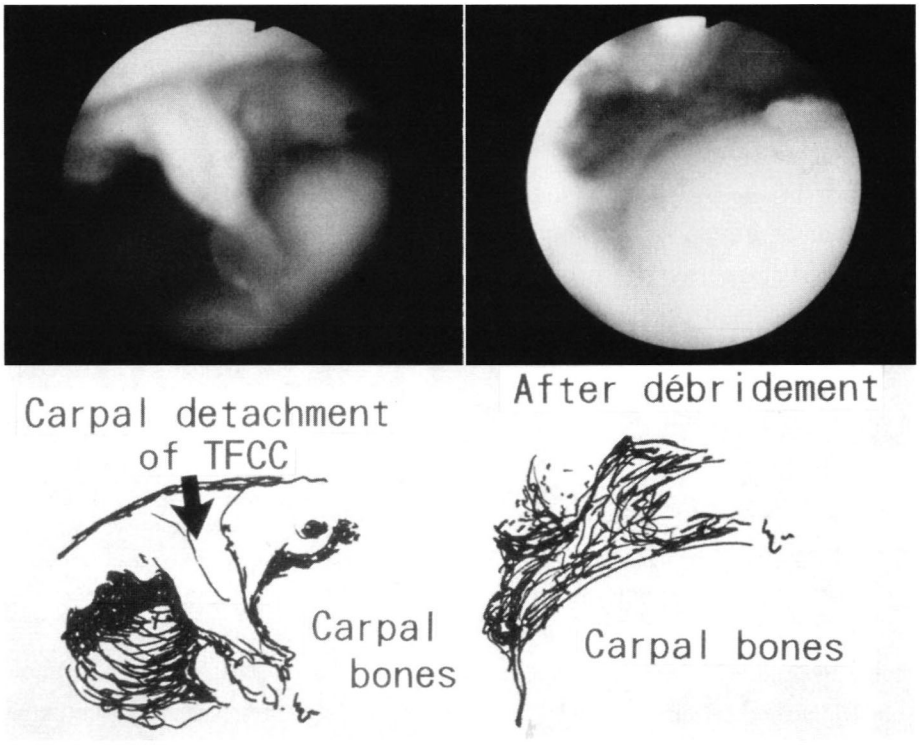


Fig. 3 A 17−year−old male.
Pain in the right wrist was experienced during rowing practice. Arthroscopic picture showing a ulnocarpal detachment of TFCC.

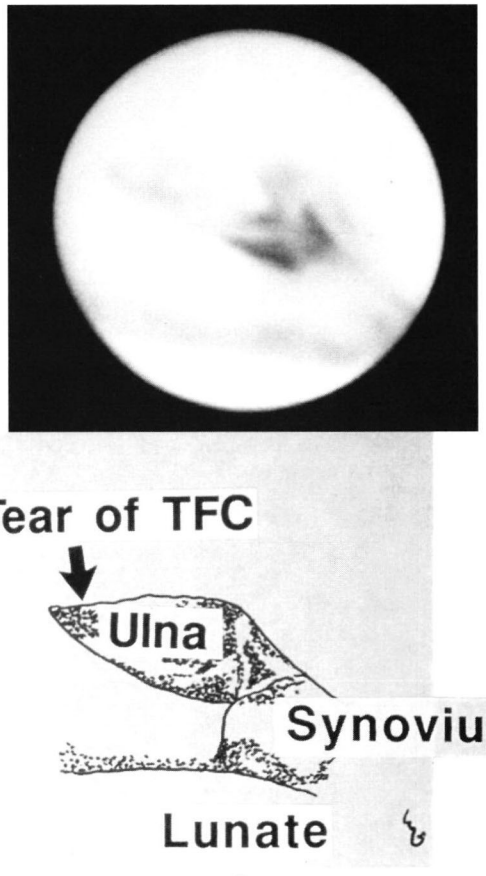
treatment is employed. Fig. 4 shows a case of pain in the wrist joint that had been caused through weight lifting. Arthrography showed extravasation of a contrast medium into the distal radio-ulnar joint. Under arthroscopy, a tear in the TFCC was confirmed, and the affected area was excised.

However, there are cases in which TFCC injuries are clinically suspected but no abnormalities can be ascertained radiographically. These patients often recover without aggressive treatment. However, in a few cases, there may be an injury to TFCC at the carpal attachment, as described in the cases given above. The wall that separates the carpal space into the radial and ulnar sides during the embryological stage may persist on the ulnar side of the carpal bone in some individuals, so that, the manner in which the TFCC is attached to the carpal side varies widely. In our recent experience, we postulate that athletic activity that exerts stress on the wrist joint could injure the TFCC when the TFCC has unusually wide attachment to the carpal bone.

We have learned from our clinical practice that the chronic TFCC injuries develop relatively frequently due to repetitive movements, in addition to TFCC injuries those caused by an obvious trauma. The symptoms are mostly pain caused by pressure or stress applied to the TFCC, characterized particularly by ulnar deviation at supination. During arthroscopy, it is important that the area around the TFCC be thoroughly examined first without the torniquet being interrupted, in order to identify any presence of proliferation by the synovium, or any abnormality in the TFC with articular motion, even when the TFC section appears normal.

In summary, when no abnormality is found in the arthrographic image in case of wrist pain, conservative treatment is chosen in most instances, athletes despite often wanting a faster recovery through more aggressive treatement such as arthroscopic surgery, because their active seasons are short. Our recent experience has taught us that after conservative treatment has been continued for a period of about 2

A



B

Fig. 4 A case of representive TFCC tears.
A : Arthrogram showing a leakage of contrast material from to the radiocarpal space to the distal radioulnar space through the tear in the TFCC.
B : Arthroscopic picture showing a torn TFCC.

month without any notable results, then wrist arthroscopy should be employed. Further studies continuing on sports-related wrist conditions to enable earlier diagnosis, treatment, and rehabilitation.

Conclusion

Radiography or MRI dose not always detect the cause of chronic pain in the wrist joint of some athletic patients. In such cases after conservative treatment has failed then arthroscopic surgery should be employed to locate the separation of the TFCC where it attached to the carpal bone. The lesion is then treated by excision. Chronic wrist pain in athletes who have a limited athletic season can be successfully managed by arthroscopic diagnosis and treatment.

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Injuries in Student Sumo Wrestlers : An Epidemiological Study

学生相撲における外傷，障害調査

Yasuaki Nakagawa 中川 泰彰 Yoshitaka Matsusue 松末 吉隆
Takashi Nakamura 中村 孝志

●Key words
Student sumo : Epidemiology : Sport injuries
学生相撲，疫学，スポーツ外傷

●Abstract
In order to study the characteristics and statistics of injuries in sumo wrestlers, we sent questionnaires to 183 students who were members of the Western Japanese Student Sumo Federation. In total, 101 completed questionnaires(55％)were returned : 72(73％)in the category of first-class and 29(34％)in the category of second-class wrestlers. In the first-class wrestlers, lower back, neck, knee and shoulder pain from injuries was more frequently reported than other pains, while knee, neck, shoulder and ankle disabilities from injuries were more frequently reported than other disabilities. The risk factors for pain were height, and length of training time. The risk factors for disabilities were a longer sumo career, and a longer training time. The risk factors for shoulder disabilities were a shorter height, a lighter weight, and a longer training time. The risk factors for knee disabilities were a heavier weight, and a higher body mass index.

●要旨
相撲による外傷，障害は多数あると思われるが，その報告は少ない。今回，学生相撲による外傷，障害の特徴を調査する目的で，西日本学生相撲連盟に所属する183名に対し，アンケート調査を実施した。回収率は一部校72名(73％)，二部校29名(34％)であった。調査時の疼痛部位としては，腰，頚，膝，肩の順に多く，今までの支障部位としては，膝，頚，肩，足関節の順に多かった。現在疼痛のない選手は一部17％，二部48％であり，今まで支障のなかった選手は一部19％，二部69％であった。腰痛を訴えるものは高身長の，肩に支障を有するものは低身長，または低体重の，膝に支障を有するものは高体重，または高肥満度の選手に多かった。

中川泰彰
〒606-8507 京都市左京区聖護院川原町54
京都大学医学部整形外科学教室
TEL 075-751-3652

Department of Orthopaedic surgery,
Faculty of Medicine, Kyoto University

Introduction

Although sumo wrestling has long been a traditional sport in Japan, the first World Sumo Championship was held as recently as 1992, when the International Sumo Federation was established. Since then, the Championships have been held every year in Japan, and sumo wrestling is now becoming a popular sport that is rapidly attracting enthusiasts from abroad. With the aim of having the sport included in the Olympics, women's sumo has also been established, using uniforms and a mat instead of the clay ring, or 'dohyo'. Therefore, it is likely that the number of sumo wrestlers, including women, will increase worldwide.

However, there have been few epidemiological reports on the subject of sumo injuries[1,2]. A high occurrence of injuries in sumo wrestlers has been suspected to occur because sumo wrestlers of very different heights and weights (for example, tall with short, heavy with light) fight each other. In order to study the statistics of injuries, we sent questionnaires to students in both first-class and second-class sumo wrestling who were members of the Western Japanese Student Sumo Federation. In Western Japanese Student Sumo Federation, 6 universities which are stronger than others belong to the first-class, and other universities belong to the second-class. Many of the sumo wrestlers in the first-class were stronger and had longer sumo careers ; many in the second-class were weaker and had shorter sumo careers. We investigated the characteristics and statistics of injuries, comparing the injuries of first - class with those of second-class wrestlers.

Materials and methods

We sent questionnaires to 183 students who were members of the Western Japanese Student Sumo Federation in 1996. This process was undertaken about two weeks before the inter-college sumo championship because it was assumed that this time was one in which the hardest training would have occurred. We studied physical aspects such as height, weight, body mass index (BMI), age, length of sumo career and training time per week, and symptoms of pain and disability from injuries. The question about pain was where he had a pain, and the question about disability was which disability he had interfered with his sport performance of sumo. We statistically compared these physical aspects with pain and disability, using Student's unpaired t-test. We found that there were significant differences between the two groups when the p value was taken as less than 5 %.

Results

In total, 101 questionnaires (55 %) were obtained : 72 (73 %) were received back from first-class wrestlers, and 29 (34 %) from second-class wrestlers.

Table 1 The mean values of physical aspects in the first-class and second-class wrestlers, showing significant differences between the two groups, using unpaired t-test.

	First-class	Second-class	p value
Height	175.1 cm	170.3 cm	0.0004
Weight	107.4 kg	74.3 kg	<0.0001
Body mass index	34.9	25.6	<0.0001
Age	20.0 years	22.2 years	<0.0001
Sumo career	8.28 years	2.36 years	<0.0001
Training time	15.8 hours/week	6.1 hours/week	<0.0001

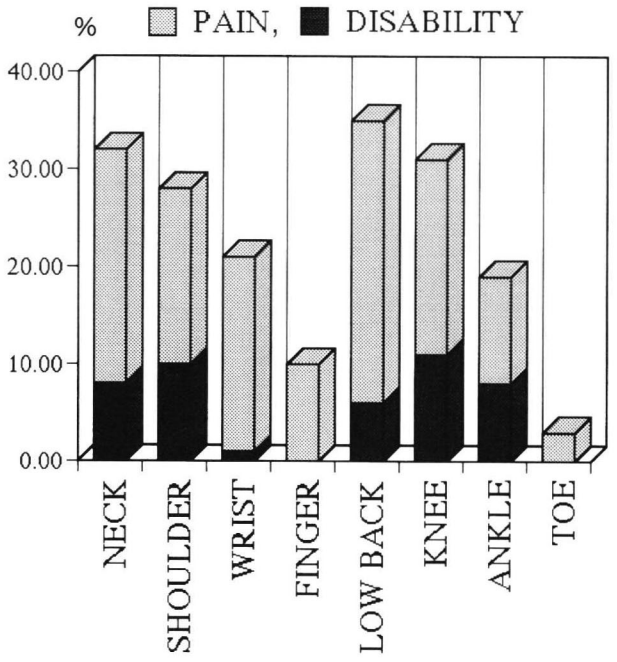

Fig 1. The frequency of pain and disability on examination : first-class.

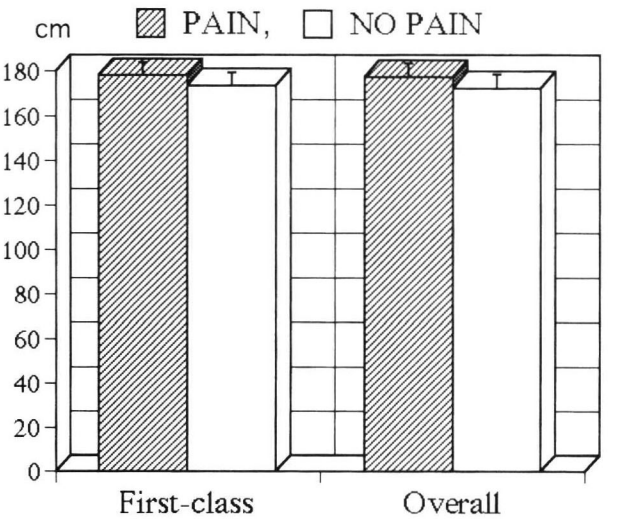

Fig. 2 The correlation between lower back pain and height, showing p values of 0.0019 in the first-class wrestlers, and 0.0004 overall.

The aspects of height, weight, body mass index, length of sumo career and training time among first-class wrestlers were more significant than those among second-class wrestlers. The age of first-class wrestlers was lower than that of second-class wrestlers (Table 1). There were significant differences between the two groups.

On examination of student sumo wrestlers in the first class, lower back, neck, knee and shoulder pain from injuries was more frequently reported than other pain, and knee, neck, shoulder and ankle disabilities were more frequently reported than other disabilities (Fig. 1). Areas of pain among the second-class wrestlers involved the whole body (for example, the neck, shoulder, elbow, wrist, finger, back, knee, ankle and toe) but the incidence was lower by about one-third than that in the first-class wrestlers. In the second-class, in only one case, disability involved the toe. In total, 26 wrestlers (26 %) reported no pain : 12 (17 %) in the first-class, and 14 (48 %) in the second-class. Sixty-nine (68 %) wrestlers reported no disability : 41 (57 %) in the first-class, and 28 (97 %) in the second-class.

The existence of pain was compared statistically with physical aspects. Among first-class wrestlers, the risk factors of pain were a taller height ($p = 0.0413$), and a shorter sumo career ($p = 0.0257$). Overall, the risk factors of pain were a heavier weight ($p = 0.0070$), a higher body mass index ($p = 0.0205$), younger age ($p = 0.0010$), and a longer training time ($p = 0.0117$). Body part pains were compared statistically with physical aspects. Not one of these aspects appeared to have any significance with regard to neck pain. Regarding lower back pain, wrestlers who were taller in the first-class ($p = 0.0019$), and overall ($p = 0.0004$) (Fig. 2), and who were heavier overall ($p = 0.0131$) reported lower back pain more frequently than others. A longer training time was a risk factor for shoulder pain overall ($p = 0.0328$). Regarding knee pain, wrestlers who had a heavier weight, and a higher body mass index, ($p = 0.0056$, and $p = 0.0112$), reported more frequent pain than others.

Knee, shoulder, neck and ankle disabilities by this time, respectively, were more frequently reported by first-class wrestlers than other disabilities, and the incidence of these disabilities was greater than 10 per

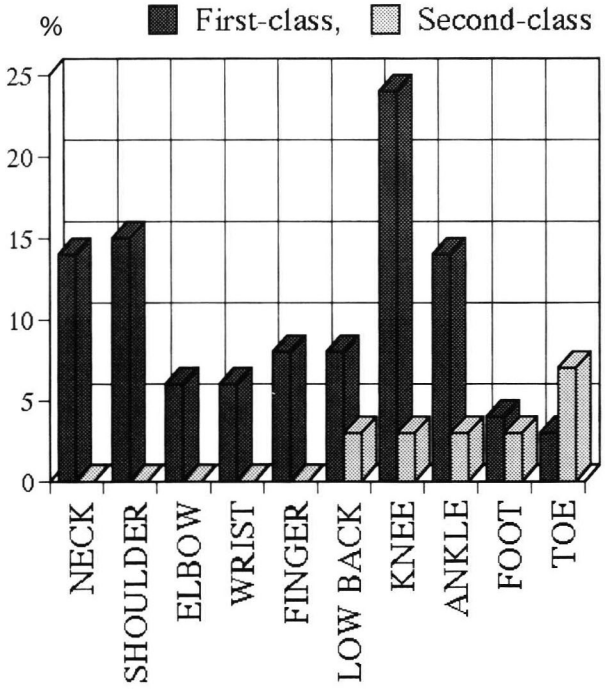

Fig. 3 The frequency of disabilities by this time in the first-class and in the second-class wrestlers.

cent (Fig. 3). In the second-class wrestlers, disabilities involved the toe, low back, knee, ankle and foot. The incidence of these was about 5 per cent and involved only the lower leg and back. Fourteen first-class wrestlers (19 %) and 20 second-class (69 %) did not report any disability. Comparison of disabilities with physical aspects revealed no significant differences in the first-class wrestlers. However, overall, all aspects revealed significant results. The p value was 0.0467 in height, 0.0017 in weight, 0.0039 in body mass index, 0.0013 in age, 0.0216 in length of sumo career, and 0.0009 in length of training time. That is, the risk factors for disabilities were a taller height, a heavier weight, a greater body mass index, a lower age, a longer sumo career, and a longer training time, overall.

Comparison of disabilities with physical aspects showed no significant influence in the neck. In the shoulder, first-class wrestlers who were shorter in height ($p = 0.0435$) or lighter in weight ($p = 0.0109$) reported disabilities frequently. Wrestlers who had a smaller body mass index tended to have a disability ($p = 0.0554$). Overall, the longer training time was

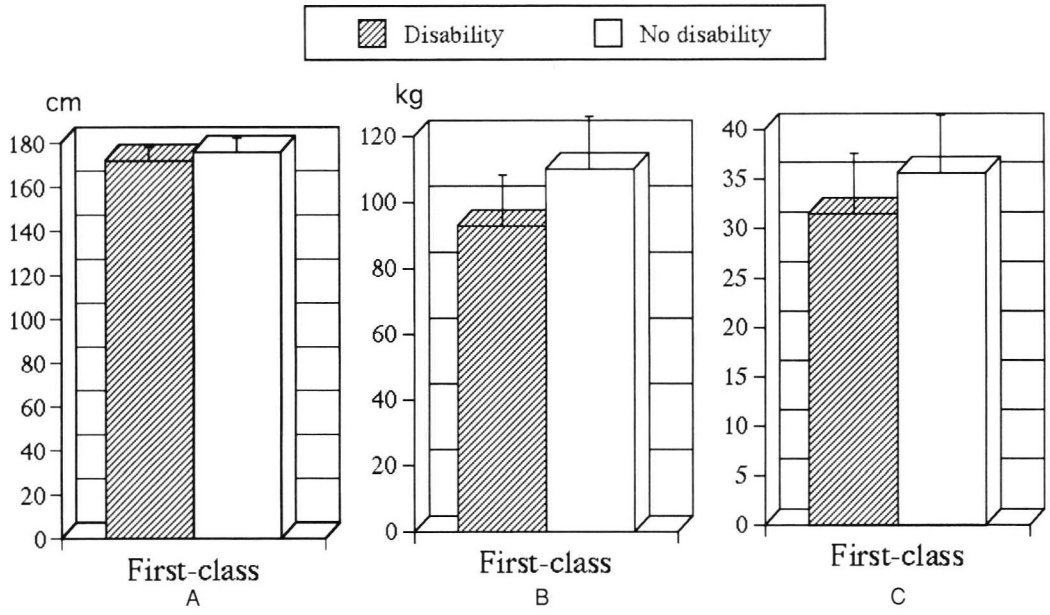

Fig. 4 The correlation between shoulder disability and height (A), weight (B), and body mass index (C). The p value was 0.0435 (A), 0.0109 (B), and 0.0554 (C), respectively.

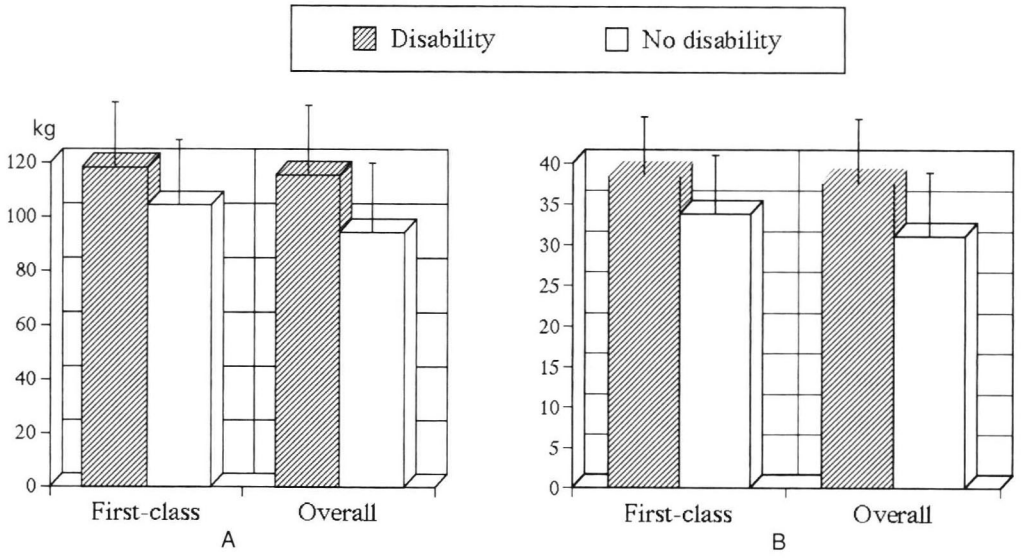

Fig. 5 The correlation between knee disability and weight(A), body mass index(B). The p value was 0.0158 in the first - class, and 0.0006 overall(A), and 0.0077 in the first - class, and 0.0004 overall(B).

only a risk factor with regard to shoulder disabilities ($p = 0.0204$). The mean value in height, weight and in body mass index of the first-class wrestlers who reported shoulder disabilities was 171.9 cm, 92.6 kg, and 31.5, respectively. The mean value of those who reported no disabilities was 175.9 cm, 110.1 kg, and 35.5, respectively. The mean value in the training time of wrestlers who reported shoulder disabilities was 17.9 hours, and that of wrestlers who reported no disabilities was 12.3 hours(Fig. 4). In the knee, the incidence of first-class wrestlers(and overall) who reported disabilities increased as their weights and body mass index increased. The p value in weight, and in body mass index, was 0.0158, and 0.0077, respectively, in the first-class, and 0.0006, and 0.0004, overall, respectively. The mean value in the weight, and in body mass index, of the wrestlers who reported knee disabilities was 118.1 kg, and 38.5, respectively, in the first-class, and 115.4 kg, and 37.7, respectively, overall. The mean value in the weight, and in the body mass index, of those who reported no disabilities was 104.1 kg, and 33.8, respectively, in the first-class, and 94.1 kg, and 31.1, respectivly, overall(Fig. 5).

The incidence of ankle disabilities of first-class wrestlers increased with increasing height ; these wrestlers were taller and heavier, overall. The p value in height was 0.0105 in the first-class ; in height, and in weight it was 0.0020, and 0.0183, respectively, overall. The mean value in height of wrestlers with ankle disabilities was 179.8 cm in the first-class, and that of wrestlers with no disability was 174.5 cm. In this latter group, the mean height was 179.5 cm and the mean weight was 114.3 kg, overall, and those of the group who reported no disabilities were 173.1 cm, and 95.9 kg, respectively.

The risk factors with regard to lower leg disabilities, including the knee and the ankle, were a heavier weight, and a higher body mass index, in the first-class wrestlers. A taller height, a heavier weight, and a greater body mass index were the risk factors, overall. In the first-class wrestlers, the p value in weight, and in body mass index, was 0.0048, and 0.0087, respectively. Overall, the p value in height, weight, and in body mass index was 0.0383, less than 0.0001, and 0.0003.

In order to study the incidences of injuries per year, we investigated the wrestlers' disabilities over

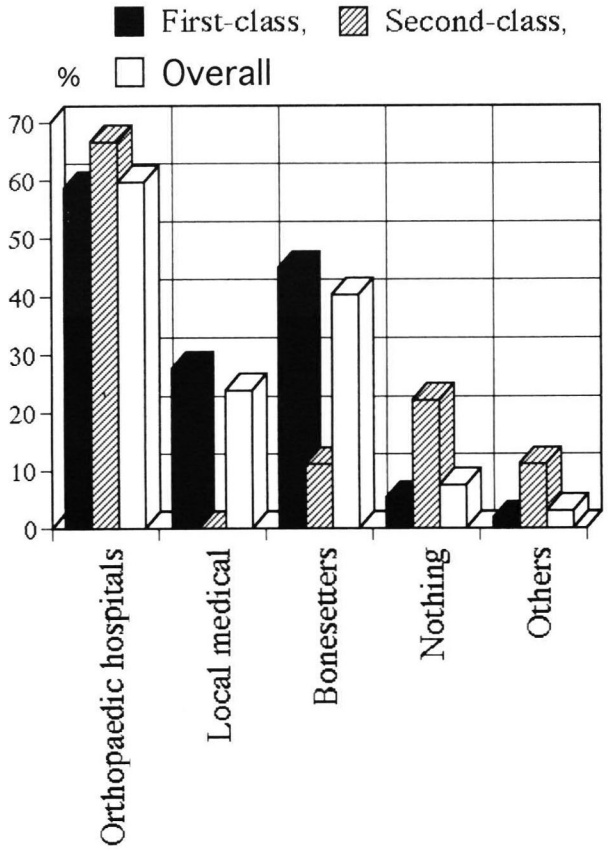

Fig. 6 The institutions where the student sumo wrestlers sought medical treatment.

the preceding year. In the first-class wrestlers, knee, ankle, lower back and elbow disabilities, respectively, were more frequently reported than other disabilities ; in the second-class wrestlers, lower back, ankle, foot and toe disabilities were more frequently reported than other disabilities. Forty-three (60 %) first-class wrestlers and 23 (79 %) second-class ones reported no disabilities over the preceding year. Sixteen (22 %) first-class wrestlers had undergone surgery by this time : six knee operations (ligament and menisci); three ankle operations and one each for a fracture in the elbow, and in the finger. Five wrestlers were obscure. No second-class wrestlers underwent surgery.

We found that injuries occurred in both classes more frequently during training than in competition : 73 % of injuries occurred during training and 18 % during competition. Treatment was sought from orthopaedic hospitals (60 %), bonesetters (40 %) and local medical establishments (24 %) (Fig. 6). Consultation occurred with team manager (45 %), no specific person (40 %), or family doctor (15 %). Team doctors were not consulted by either class. In this regard, there was hardly any difference between first-class wrestlers and second-class wrestlers.

Discussion

In our study, height, weight, body mass index, length of sumo career and training time in first-class wrestlers were each greater than that in the second-class wrestlers ; only age in the first-class wrestlers was less than that in the second-class wrestlers. There was significant difference between the two groups. Therefore, when we statistically compared physical aspects with pain or disability, height, weight, body mass index and age needed to be compared in the first-class, and length of sumo career and training time needed to be compared, overall. That is, the risk factors for pain were a taller height, and a longer training time. The former may be related to the fact that lower back pain in the wrestlers increased as their heights increased. The latter is a generally accepted finding. The risk factor for lower back pain was a taller height (Fig. 2). This might be explained by the fact that wrestlers' paravertebral muscle power did not increase as their height increased, and that they frequently had to extend the lumbar area because of their height when they engaged in sumo wrestling. The risk factor for shoulder pain was longer training time. The reason for this was not clear.

The risk factors for disabilities were a longer sumo career, and a longer training time. This is a generally accepted finding. Tsuchiya et al. reported that the risk factors for sumo injuries were a taller height and a heavier weight[3]. However, in our study, only a taller height was the risk factor for pain. A heavier weight and a bigger body mass index were not the

risk factor for pain, and a taller height, a heavier weight and a bigger body mass index were not the risk factor for disability in the first-class. The risk factors for shoulder disabilities were a shorter height, a lighter weight, and a longer training time (Fig. 4). Yoneda et al. reported that judo players who were lighter frequently reported more shoulder disabilities[4,5]. Sumo has the same characteristics as judo in this regard. The risk factors for knee disabilities were a heavier weight, and a higher body mass index (Fig. 5). Yoneda et al. reported that judo players who were heavier had knee disabilities more frequently[4,5]. Sumo has the same characteristics as judo in this regard, as well. The risk factor for ankle disabilities was a taller height. The reason for this might be that height had an adverse effect on the ankles.

In our study, lower back, neck, knee and shoulder pain, respectively, were more frequently reported than other pain on examination of student sumo wrestlers. Knee, neck, shoulder and ankle disabilities, respectively, were more frequently reported than other disabilities in the first-class wrestlers. Tsuchiya et al. (from hospital observations) reported that lower back, knee, shoulder and ankle disabilities, respectively, were more frequently reported than other disabilities in professional sumo wrestlers[1]. It appeared that although neck pain and disabilities were frequent in sumo wrestlers, they did not seek hospital treatment, probably because their neck disabilities were not serious. It also appeared that sumo wrestlers injured knee and shoulder joints most frequently than other parts.

Conclusion

1. We have reported the results of 101 questionnaires from sumo wrestlers who were members of the Western Japanese Student Sumo Federation in order to study the characteristics and statistics of their injuries.
2. Lower back, neck, knee and shoulder pain was more frequently reported than other pain, and knee, neck, shoulder and ankle disabilities were more frequently reported than other disabilities, in the first-class wrestlers.
3. Twelve first-class wrestlers (17 %) and 14 second-class wrestlers (48 %) reported no pain. Forty-one first-class wrestlers (57 %) and 28 second-class wrestlers (97 %) reported no disability.
4. The risk factors for shoulder disabilities were a shorter height, a lighter weight, and a longer training time. The risk factors for knee disabilities were a heavier weight, and a higher body mass index.

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Importance of Explosive Muscle Strength in Achieving a Return to Competitive Sports : Evaluation of Motor Dysfunction in Jump Landing

競技復帰の可否における瞬時発揮筋力の重要性
—ジャンプ着地動作機能不全の評価—

Toshiharu Yamamoto 山本 利春[1)] Saburoh Arima 有馬 三郎[2)]
Keizo Sakamoto 阪本 桂造[3)] Etsuo Fujimaki 藤巻 悦夫[3)]

● Key words
Evaluation of muscle strength : Dysfunction in jump landing
筋力評価，ジャンプ着地障害

● Abstract
We have conducted a study to investigate any correlation between the explosive muscle strength and recovery from a jumping motor dysfunction. The muscle strength of 16 athletes with a jumping motor dysfunction was measured progressively until improvement in their jumping motor function was achieved. Maximum isometric muscle strength in the knee extension was measured in order to calculate the peak muscle force and muscle force at 0.2 and 0.4 seconds after the initial expression force. Change in the muscle force around the time of achieving an improvement in jumping motor dysfunction was + 63.7 % at 0.2 seconds and + 30.3 % at 0.4 seconds after the initial expression force and + 7.8 % at peak force. More specifically, increase in the muscle force at around the time of improvement of the jumping motor dysfunction was more remarkable when initially expressed than at the time of attaining the peak force. These findings suggested that the level of muscle force when it was first expressed should be investigated in addition to the peak muscle force when evaluating the capacity of motor dysfunctional athletes who need to express a powerful explosive muscle strength in order to instantaneously shift their body weight for actions such as jumping.

山本利春
〒299-5295 千葉県勝浦市新官841
国際武道大学体育学部
TEL 0470-73-4124

1) Faculty of Physical Education, International Budo University
2) Katsuura Orthopaedic Clinic
3) Department of Orthopaedic Surgery, Showa University School of Medicine

●要旨

本研究では，瞬時に発揮する筋力の評価がジャンプ動作障害の回復に関連性があるか否かを検討した。ジャンプ動作に障害をもつ16名のスポーツ選手を対象として，ジャンプ動作改善時まで経時的に筋力測定を行った。筋力は膝関節における等尺性最大伸展力を測定し，最大筋力，および筋力発揮後0.2秒，0.4秒後に発揮しえた筋力を算出した。その結果，ジャンプ障害改善前後の筋力の変化は，0.2秒後の筋力(＋63.7％)，0.4秒後の筋力(＋30.3％)，最大筋力(＋7.8％)の順に大きかった。すなわち，ジャンプ障害改善前後の筋力の増加は，最大筋力よりむしろ力の立ち上がりを示す瞬時に発揮された筋力のほうが顕著であった。以上のことから，ジャンプ動作のように身体自重が瞬間的に作用し，大きな筋力を瞬時に発揮することが必要となる動作に障害を有するものに対して機能評価を行う際には，最大筋力に加えて筋力発揮開始初期の筋力をも合わせて検討することが有効であると考えられた。

Introduction

There are numerous cases of athletes whose muscle strength has recovered, but whose motor function remains inadequate, there by preventing them from achieving a successful return to competitive sport. One causative factor underlying this phenomenon is inadequate explosive expression (start-up) of muscle force.

The most widely used conventional method of evaluating muscle function utilizes the maximum value of muscle force achieved (peak force, peak torque, etc.). Furthermore, with the development of myodynamometric equipment in recent years, computer analysis of the maximum values of muscle force alone has become the method of first choice. As shown in Fig. 1, a method that measures the peak muscle force alone cannot be used to evaluate the initially expressed force (explosive expression of muscle force) when the initial generation of the force differs even if the peaks are equal. The muscle strength needed to instantaneously support and move the body's weight in order to jump or run during a sporting activity is generated in an extremely short time of 0.1-0.2 seconds ; moreover, it is not merely a large muscle force that is important, but also the amount of muscle force that can be generated instantaneously. This indicates that in terms of judging whether or not a return to competitive sport is possible and in planning an athlete's training regime after recovery from an injury, there are risks associated with evaluating the subject's myodynamic function on the basis of the peak muscle force values alone. It is especially important to bear this fact in mind when the sport involved requires motor functions that must provide instantaneous support of the body's weight during sudden movements such as jumping.

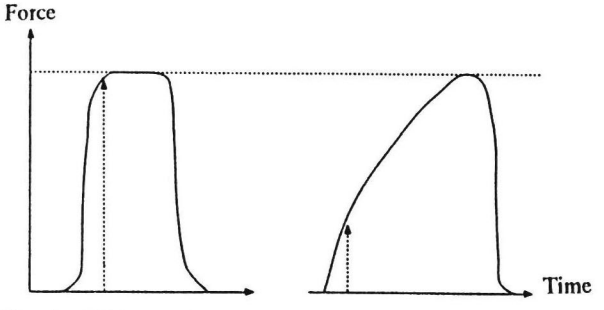

Fig. 1 Different force start-ups and muscle force during the initial expression period

In the present study, in order to investigate an optimum method for evaluating the myodynamics of athletes with a dysfunction in jump landing, which is a heavy load occurring during many sporting activities, we measured the peak muscle force and explosive muscle strength from the time at which normal jumping was not possible because of anxiety, pain or the inability to sustain continuous exertion, in sub-

jects with a dysfunction in the lower extremities and compared the results during the jumping dysfunction period with the values obtained after the dysfunction had improved.

Materials and methods

The subjects consisted of 16 university physical education undergraduates (13 males, 3 females, mean age : 19.3 ± 0.8 years) suffering from a jump dysfunction arising largely from knee injury. Patients with diagnosed of 6 jumper's knee, 4 after op. for a meniscus injuries, 2 ACL recountractions, 2 MCL injuries, 2 after op. for Osgood's diseases.

During the rehabilitation and training to the quadriceps mainly for these patients, their muscle force was measured progressively from when they were incapable of normal jumping because of anxiety, pain or the inability to sustain continuous exertion, until their condition had improved. Isometric testing was assessed using a Cybex II dynamometer (Lumex, Inc., NY) and the maximum isometric muscle force was measured with the knee extension in the 70 degree flexion position for obtaining the maximum muscle strength, under the dynamometer was

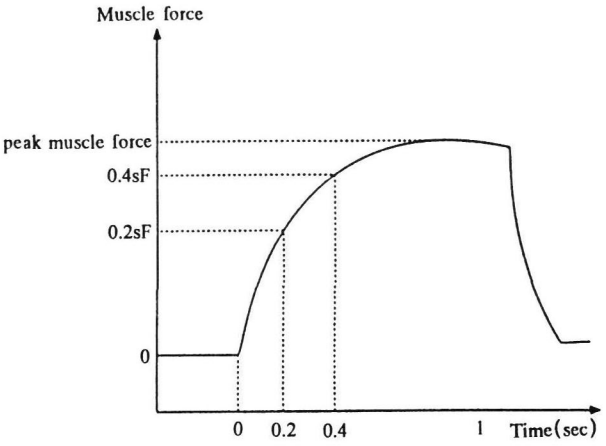

Fig. 2 Method of muscle force-time curve analysis

tested at 0 deg./sec. Peak muscle force and the force at 0.2 seconds (0.2 sF) and 0.4 seconds (0.4 sF) after the start of the isometric muscle contraction were estimated from the muscle force versus time curve. These data were measured by the mesured dynamometer lever arm lengths and peak torque values, this peak torque values were divided by the lever arm length, transformed the force unit (kg), and peak muscle force ratio and body weight ratios were calculated for all the values obtained (Fig. 2).

The jump dysfunction among the subjects of the present study manifested largely as pain or anxiety

Table 1 Comparison of muscle force measurements at the time of jumping dysfunction and after Improvement in the jumping dysfunction

	Jump dysfunction	Improvement in jump dysfunction
Body weight (kg)	70.8 ± 11.3	70.8 ± 11.4
0.2sF (kg)	37.3 ± 11.6	55.3 ± 14.4***
0.4sF (kg)	50.0 ± 12.9	63.3 ± 15.4**
Peak muscle force (kg)	69.0 ± 14.9	74.7 ± 17.8**
0.2sF/body weight	0.54 ± 0.17	0.78 ± 0.18***
0.4sF/body weight	0.71 ± 0.16	0.90 ± 0.19***
Peak muscle force/body weight	0.98 ± 0.15	1.05 ± 0.19**
0.2sF/peak muscle force	0.55 ± 0.15	0.74 ± 0.08***
0.4sF/peak muscle force	0.73 ± 0.13	0.85 ± 0.06**

Mean ± SD **:$p<0.01$, ***:$p<0.001$

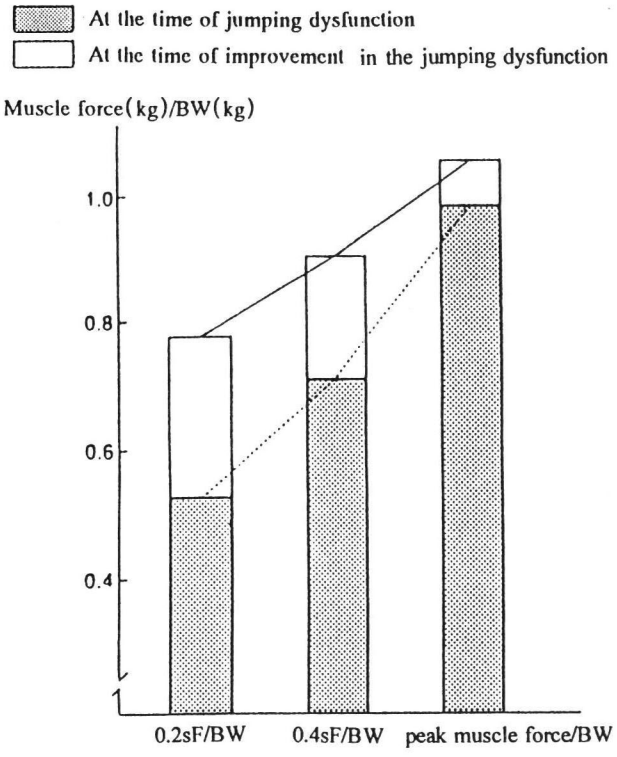

Fig. 3 Change in peak force per unit body weight(BW) after improvement in jumping dysfunction, and muscle force at 0.2 sec and 0.4 sec after the start-up of muscle force(0.2sF, 0.4sF).

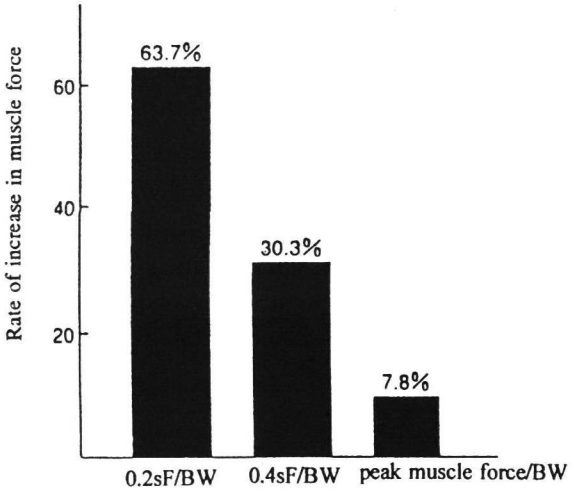

Fig. 4 Rate of increase in muscle force after improvement in jumping dysfunction.
BW : body weight.

symptoms on actual jumping and was regarded as a state causing impairment in jump landing and in continuous jumping on one leg at full effort. The control group consisted of 27 normal healthy male jumping athletes currently engaged in competitive level sporting activities.

Results

The mean interval between the day of first measuring the muscle force around the time at which the jumping dysfunction had occurred and the day of measuring the muscle force after it had improved was 24.5 ± 19.4 days. When the jumping dysfunction had improved, most every patients were achived a return to competitive sports.

Values of the peak, 0.2sF and 0.4sF isometric muscle force after the jumping dysfunction had improved were significantly larger than those measured during the dysfunction period(Table 1). Significant increases were seen also in the force-weight ratios for the peak, 0.2sF and 0.4sF values. Change in the muscle force at the time of improvement in the jumping dysfunction occurred in the order of 0.2sF > 0.4sF > peak force, and the magnitude of the change in each case was large(Fig. 3). The rate of increase in muscle force was 63.7 % for 0.2sF, 30.3 % for 0.4sF and 7.8 % for the peak force(Fig. 4).

The peak force ratio after improvement in the jumping dysfunction was significantly higher than that measured before improvement, similar to the results for 0.2sF and 0.4sF.

Table 2 shows the measured values of each parameter in normal jumping athletes currently engaged in competitive-level sporting activities. Comparison of the measured values of the normal jumping athletes, with the subjects' values at the time of their dysfunction and after their disorder had improved, revealed higher values in the normal jumping athletes, although the values were significantly higher only in comparison with the 0.4sF and the peak force values of the dysfunctional group after improvement,

Table 2 Comparison of muscle force measurements of healthy jumping athletes with those of patients suffering from jumping dysfunction(B : At the time of the jumping dysfunction, A : After improvement in the jumping dysfunction)

Jumping athletes (N=27)		B	A
Body weight (kg)	69.7 ± 6.9	n.s.	n.s
0.2sF (kg)	71.9 ± 7.2	***	***
0.4sF (kg)	79.6 ± 8.5	***	***
Peak muscle force (kg)	90.7 ± 9.9	***	***
0.2sF/body weight	1.04 ± 0.09	***	***
0.4sF/body weight	1.15 ± 0.10	***	***
Peak muscle force/body weight	1.30 ± 0.12	***	***
0.2sF/peak muscle force	0.80 ± 0.07	***	**
0.4sF/peak muscle force	0.88 ± 0.06	***	n.s.

Mean ± SD **:p<0.01 , ***p<0.001

(Table 2).

Discussion

1. Factors underlying the explosive expression muscle force(start-up force)

The findings of the present study revealed a significant increase in all the parameters of isometric knee extension muscle activity, including the peak force as well as the 0.2sF and 0.4sF values measured after the start of muscle force expression following improvement in the jumping dysfunction due to rehabilitation and training. In particular, the most remarkable increase was seen in the 0.2sF, which can be regarded as the explosive muscle force(Fig. 4).

Research on the capacity to elicit explosive muscle force or "muscle force start-up" has been conducted for many years, and various reports have appeared suggesting that muscle strength training improves muscle force start-up[1, 2, 8 ~ 10] and that a close correlation existed with manifested power in single actions[5, 11].

It has been suggested that the action of the nervous system was a major factor underlying the effectiveness of training on muscle force start-up[4]. Kaneko[5] reported that the muscle force curve and electromyographic findings during extension movement of the knee indicated that the concentration of nerve impulses exerted an influence on muscle force start-up and muscle contraction induced by electrical stimulation provided evidence to support this notion. The expression of a large explosive muscle force in a short time is influenced by the number of motor units or the frequency of impulse discharges[4]. However, in the case of voluntary contraction, the amount of impulse discharges ultimately is determined by regulation from the level of cerebral stimulation and the lower central nerves and can be affected by the subject's psychological state at the time[3].

Accordingly, in athletes affected by anxiety or pain during jumping movements, such as the subjects with jumping dysfunction investigated in the present study, the underlying neurological factors are probably substantial and the potential for resolution high.

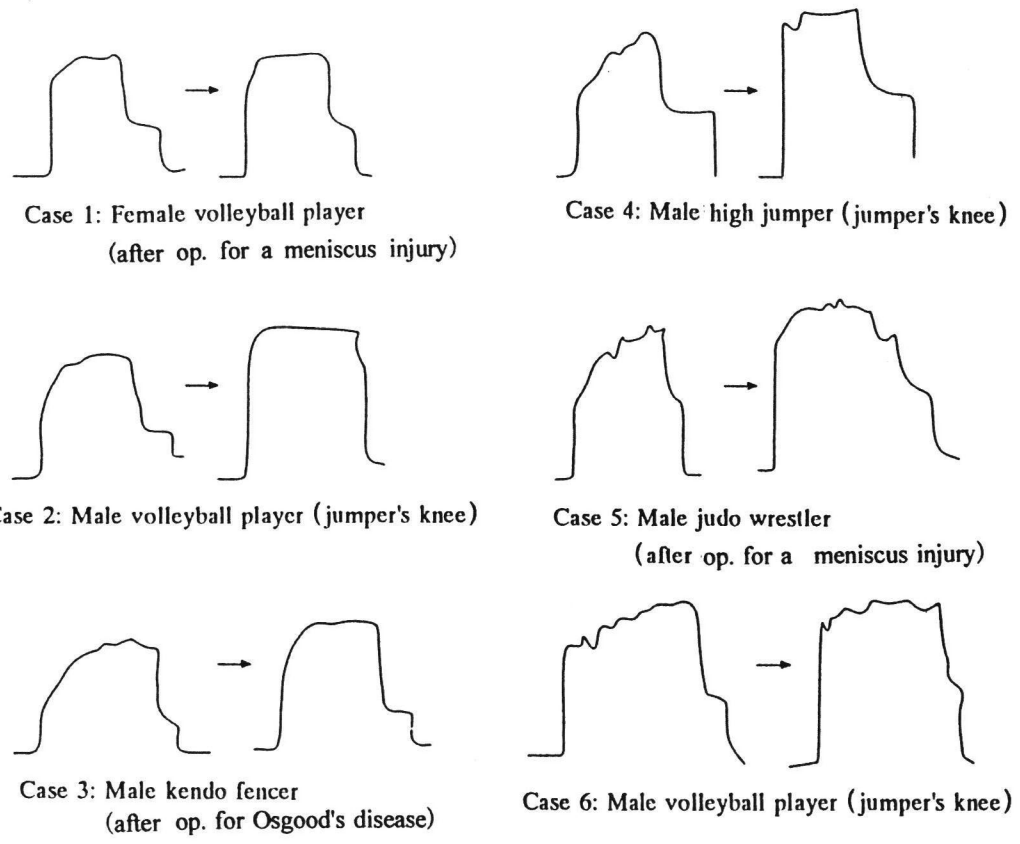

Fig. 5 Changes in the muscle force-time curve at the time of a jumping dysfunction (left) and after improvement in the jumping dysfunction (right).
The figures show that the state of muscle force start-up is a factor underlying functional recovery.

2. Importance of evaluating explosive muscle force (start-up force)

Muscles of the lower extremities are used widely as an index for evaluating whether or not an athlete can achieve a comeback after a lower extremities injury. The most commonly used method of evaluating the muscle strength of the lower extremities is to assess the degree of recovery in the peak force. Moreover, indices used in the evaluation include involved-volved peak force ratio (bilateral imbalance), flexion-extension the peak force ratio and the peak force weight ratio.

However, when movements are actually carried out at the site of the sporting activities, the athletes must be able to exhibit explosive muscle force for sudden actions that place a heavy load on the body, such as jumping movements. Accordingly, merely exhibiting a powerful muscle force without the capacity to express a powerful explosive muscle force is not sufficient for the skillful accomplishment of sporting movements.

According to a report by Viitasalo and Komi[11] even among competitors with the same muscle fiber composition and peak force, the leg extensor muscles of ski jumpers had a more powerful muscle force start-up than those of untrained people. Kaneko[5] similarly found that among competitors with the same level of peak force, those with a better muscle force start-up showed greater power and a higher level of muscle electric discharge from the start of muscle activity. In the present study as well, we found that improvement in muscle force after recov-

ery from a jumping dysfunction was more remarkable at 0.2 seconds and 0.4 seconds after the initial expression of muscle force, which indicated the muscle force start-up, rather than the peak force. These findings suggested that the peak muscle force alone should not be used to evaluate function, but should be combined with an evaluation of the capacity to express explosive muscle force, which is demonstrated by force start-up.

Fig. 5 shows the post-improvement muscle force curves of the subpopulation of patients investigated in this study who showed a remarkable improvement in their jumping dysfunction. As can be seen in this figure, even subjectively, the state of force start-up was clearly involved in the recovery of function.

Comparison of normal jumping athletes involved in competitive-level sporting activities with subjects suffering from a jumping dysfunction revealed that among the parameters showing the muscle force at start-up, the peak force ratio showed the least difference between the two groups and significant differences were not seen in the 0.4sF or peak force values between the normal athletes and the subjects after their jumping dysfunction had improved (Table 2). More specifically, if the muscle force start-up is evaluated based on the criterion of the peak force values, it may not be possible to make an appropriate functional evaluation in cases where the peak force values are low. Accordingly, assuming that muscle force start-up can be used as an index for the functional evaluation of a patient, the force start-up gradient (rate of force increase per unit time) and evaluation of the time elapsing from the initial expression of muscle force start-up until the peak muscle force is attained are not adequate as evaluation parameters as it is also essential to evaluate whether or not the subject has the capacity to elicit the explosive muscle force needed to express certain prescribed instantaneous movements.

Kigawa et al.[7] reported finding that a fixed correlation existed between the recovery of fundamental motor functions, such as walking, running and jumping, and isometric muscle force of the knee joint during rehabilitation. Most movements of the body centered around the lower extremities, such as jumping, require the load of the athlete's own body weight to be supported and shifted, which means that the muscle force of the lower extremities (peak isometric muscle force in the knee joint) must approximate the body weight[6].

Body movements, such as jump landing, using the lower extremities, as stated above, require the full load of the athlete's own body weight to be supported and shifted, hence it is appropriate to evaluate whether or not the athlete can express an explosive muscle force in the lower extremities (isometric muscle force in the knee joint) that is equivalent to the body weight in order to shift the body during movement. The findings of the present study suggested that the 0.2sF-weight ratio measurement, which showed the greatest change after the improvement of jumping dysfunction, was an extremely useful index for evaluating the degree to which the subject's muscle force can support the body weight during explosive muscle activities (such as at the instant of landing from a jump). The results of this study alone do not suffice to state definitively that this index was the most appropriate. However, our findings clearly indicated that this index was extremely useful for evaluating a patient's capacity after improvement in jumping dysfunction.

Conclusion

The findings of the present study indicated that for the functional evaluation of patients with an impairment in motor function needed to express an explosive muscle force powerful enough to shift the weight of the body instantaneously, such as in jumping movements, it was extremely useful to investigate the level of muscle force (force start-up, etc.) during the early period after the initial expression of muscle power.

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Bone Tunnel Enlargement following Anterior Cruciate Ligament Reconstruction

前十字靱帯再建術後の骨孔拡大について

Izumi Kanisawa	蟹沢　泉	Hideshige Moriya	守屋　秀繁
Akihiro Tsuchiya	土屋　明弘	Yuuichi Wada	和田　佑一
Noriyuki Ishige	石毛　徳之	Akira Katsumi	勝見　明

● Key words

Anterior cruciate ligament reconstruction : Bone tunnel

前十字靱帯再建術，骨孔

● Abstract

Enlargement of the bone tunnel following anterior cruciate ligament reconstruction has been reported by several authors mainly in regard to bone patellar tendon bone reconstruction. The purpose of this study was to examine bone tunnel enlargement following each of two different techniques of anterior cruciate ligament reconstruction which we have performed using either the iliotibial tract or the hamstring tendons. The ITT Group included 14 cases who received reconstruction using the iliotibial tract, while the STG Group included 11 cases who received reconstruction using multiple strands of the semitendinosus and gracilis tendons. Femoral tunnel enlargement was discovered in both groups and the ITT Group showed a significantly greater enlargement than did the STG Group. The tibial tunnel did not show any significant enlargement. No correlation was found between the femoral tunnel enlargement and the diameter of the graft or the postoperative anterior−posterior translation.

●要旨

近年前十字靱帯再建術後の骨孔の拡大に関する報告が散見されるが，骨付膝蓋腱に関するものが主である。われわれは腸脛靱帯ないしは膝屈筋腱による再建術を行っており，今回この2種類の術式の術後の骨孔拡大について検討した。腸脛靱帯による再建(ITT群)14例，半腱様筋腱，薄筋腱による再建(STG群)11例の計25例を対象とし，術後の2方向単純X線像により検討した。その結果両群とも大腿骨孔に拡大を認めたが，ITT群はSTG群に比し有意に大きな拡大を認めた。脛骨骨孔には有意な拡大はみられなかった。骨孔拡大と再建靱帯の径や術後の前後動揺性については有意な相関はみられなかった。

蟹沢　泉
〒260−8677　千葉市中央区亥鼻1−8−1
千葉大学医学部整形外科学教室
TEL 043−222−7171/FAX 043−226−2116

Department of Orthopaedic Surgery,
School of Medicine Chiba University

Introduction

Enlargement of the bone tunnel following anterior cruciate ligament reconstruction has been reported using autograft, as well as artificial ligament or allograft reconstruction[1~5]. Most reports were in regard to bone patellar tendon bone reconstruction and only a few reports were about bone tunnel enlargement following anterior cruciate ligament reconstruction using iliotibial tract or hamstrings. We have performed anterior cruciate ligament reconstructions using autogenous iliotibial tract since 1979, and since 1995 we have also performed reconstructions using multiple strands of the semitendinosus and gracilis tendons, as part of a randomized study. The purpose of this study was to examine the bone tunnel enlargement following these two different techniques of anterior cruciate ligament reconstruction which we have performed.

Materials and methods

From September, 1995 to September, 1996 we performed anterior cruciate ligament reconstruction for 25 patients using either the iliotibial tract or multiple strands of the semitendinosus and gracilis tendons. Anterior cruciate ligament reconstruction using the iliotibial tract was parformed in 14 cases, involving 8 males and 6 females (the ITT Group), and reconstruction using multiple strands of the semitendinosus and gracilis tendons in 11 cases, involving 6 males and 5 females (the STG Group). The mean age at surgery of each group was 24.6 years old (range 14 to 42), and 24.3 years old (range 17 to 31), respectively. The follw-up period was a minimum of 7 months, with a mean of 13 months, and 14 months, respectively. The opeative methods in the ITT Group were both intra- and extra-articular anterior cruciate ligament reconstruction as we have already reported. The STG Group received anterior cruciate ligament reconstruction using 2 or 3 times folded semitendinosus and gracilis tendons which had non-absorbable sutures at both ends of the graft, fixed to the femur and tibia with buttons. Bone tunnels of both groups were made through a modified over-the-top route using the same outside-in method. Postoperatively, all patients followed an early rehabilitation protocol which included immediate joint motion using a continuous passive motion device and early weight bearing as much as tolerable.

Bone tunnels were evaluated using A-P and lateral view plain radiograms. Radiograms were taken several times for each case during the follow-up period, and we evaluated the most recent one in this study. The diameter of the femoral bone tunnel with sclerotic margin was measured at the widest portion on the A-P view radiogram (Fig. 1), and the shape of the femoral bone tunnel was classified into one of 4 types ; parallel, lateral-opening, medial-opening, or unclear-margin (Fig. 2). The diameter measured on the lateral view was excluded from this study because we could not detect the margin of the femoral tunnel accurately. The diameter of the tibial bone tunnel with sclerotic margin was measured on both the A-P and the lateral view radiograms. The difference between the radiographic diameter of the bone tunnel and the diameter of the drill bit that was used to make the tunnel during surgery was taken to be the tunnel enlargement value. No correction for radiographic magnification was performed. The postoperative anterior-posterior stability of the knee was evaluated using a KT-1000 arthrometer (MEDmetric Corporation) at 3 to 4 months after surgery. Correlations between the tunnel enlargment and the diameter of the graft that was measured during surgery were also investigated. Statistical analysis were parformed using Mann-Whitney's U-test and Spearman's rank correlation.

Results

The mean femoral tunnel enlargement value was 5.2 mm (3-8 mm) in the ITT Group, and 2.8 mm (1-5

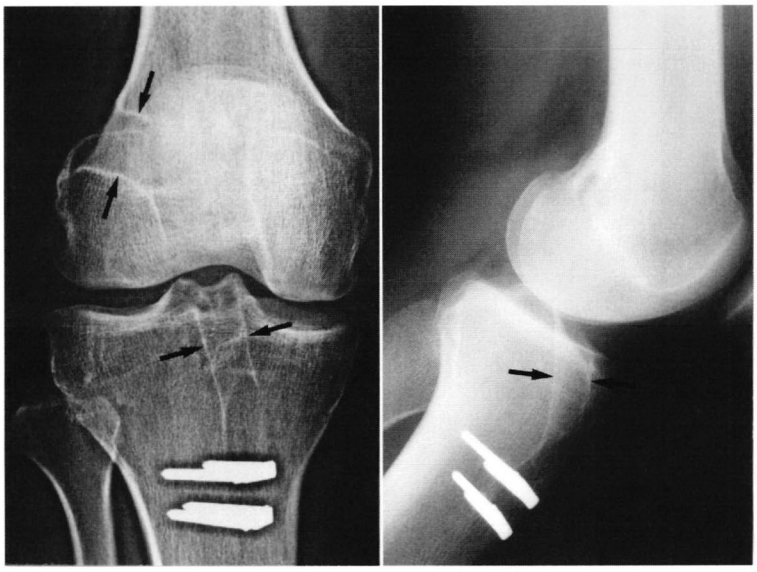
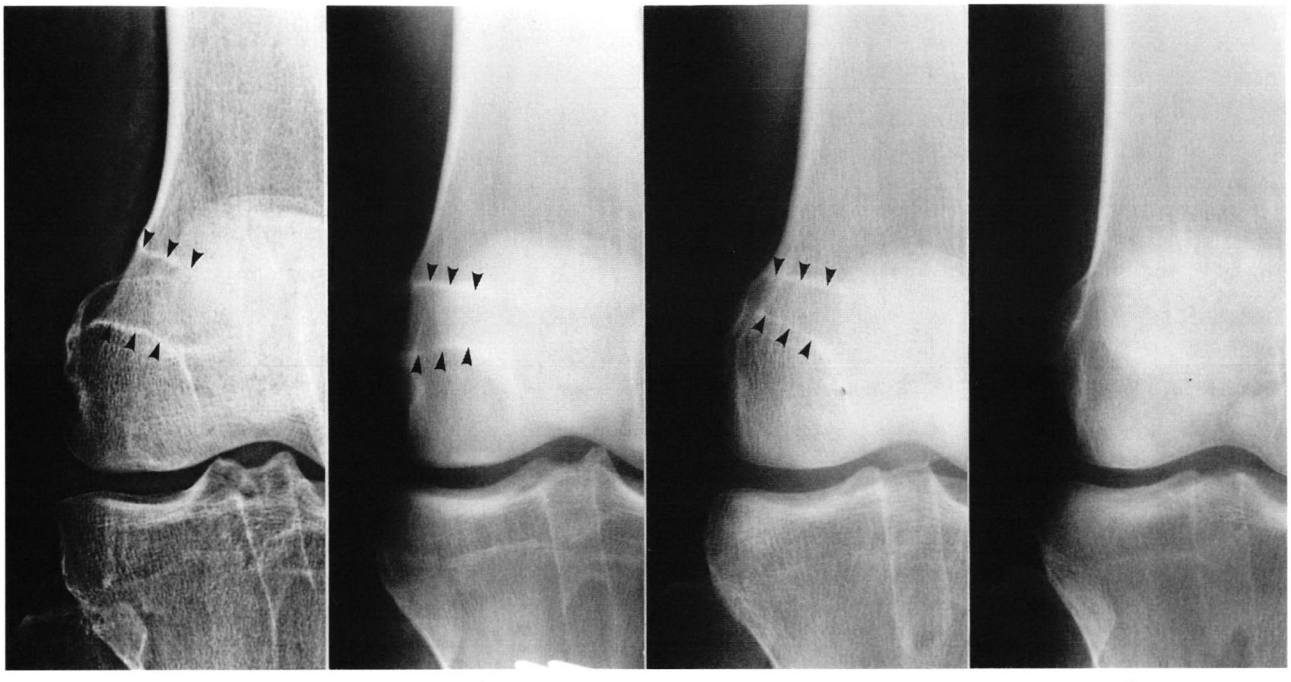


Fig. 1 Measurement of the diameter of the bone tunnel.
The diameter of the femoral bone tunnel was measured on an A-P view radiogram, and the diameter of the tibial bone tunnel was measured on both the A-P and the lateral view radiograms at the widest portion of the sclerotic margin.



a b c d

Fig. 2 Classification of the femoral bone tunnel.
The shape of the femoral bone tunnel was classified into one of four types, a) parallel, b) lateral-opening, c) medial-opening, or d) unclear-margin.

Table 1 Bone tunnel enlargement value

	Bone tunnel enlargement value (mm)	
	ITT Group	STG Group
Femur	5.2±1.5*	2.8±1.4
Tibia A-P	1.2±0.4	1.7±0.7
Lateral	1.0±0.5	1.6±0.7

* $p < 0.01$ compared with STG Group

Table 2 Classification of the shape of the femoral bone tunnel

Type	No. of cases	
	ITT Group	STG Group
Parallel	11	4
Lateral-opening	3	0
Medial-opening	0	5
Unclear-margin	0	2

mm) in the STG Group (Table 1). Statistical examination revealed that the ITT Group showed a femoral enlargement value signifcantly greater than the STG Group ($p<0.01$). The bone tunnel enlargement value in the tibia was 1 or 2 mm in most cases, and no statistically significant difference was found between the two groups (Table 1).

The most common shape of the femoral tunnel in the ITT Group was parallel type in 11 cases, followed next by lateral-opening type in 3 cases. On the other hand, the most common shape in the STG Group was medial-opening type in 5 cases, followed next by parallel type in 4 cases, and unclear-margin type in 2 cases (Table 2).

No significant correlation was found between the bone tunnel enlargement value and the anterior-posterior translation measured using a KT-1000 arthrometer (Fig. 3). Side-to-side differences in the anterior-posterior translation were within 3 mm, except for 3 cases in the ITT Group and 2 cases in the STG Group.

The graft diameter of each case was between 8 and 10 mm, and no significant correlation was found between the bone tunnel enlargement value and the graft diameter (Fig. 4).

Discussion

Recently several authors have reported the phenomenon of bone tunnel enlargement following anterior cruciate ligament reconstruction, including its cause and affective factors. Two major affective factors—a biochemical factor and a biomechanical factor—have been postulated. Bone tunnel enlargement following artificial ligament or allograft reconstruction has been considered to be caused mainly by the biochemical factor, by several authors[1,2]. On the other hand, enlargement caused by the biomechanical factors has been reported following autograft anterior cruciate ligament reconstruction. The diameter, length of the graft and fixation position of the graft have each been discovered to be correlated with enlargement[3-5].

Although radiographic magnification was not correcetd in this study, the expected enlargement in the diameter due to magnification is less than 2 mm. Hence, femoral tunnel enlargement existed in both groups. On the other hand, the bone tunnel enlargement value of the tibia was 1 or 2 mm in most cases. When radiographic magnification was considered, no significant enlargement in the tibial bone tunnel was observed.

Although the methods of bone tunnel placement and postoperative rehabilitation were identical with both the ITT and the STG Groups, a significant difference in tunnel enlargement was found between the two groups. The results showed an enlargement in the femoral bone tunnle of the ITT Group significantly greater than that of the STG Group. As to the shape of the femoral bone tunnel, the ITT Group had 3 cases of lateral-opening type and the STG Group had 5 cases of medial-opening type and 2 cases of

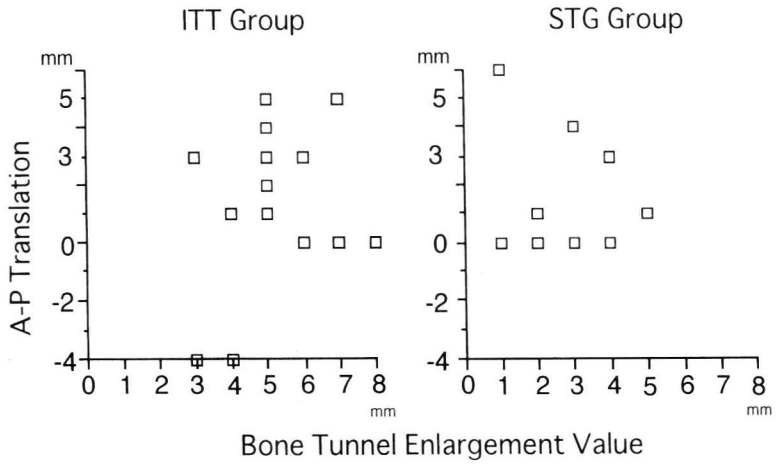


Fig. 3 Bone tunnel enlargement value and A−P translation measured using a KT−1000 arthrometer

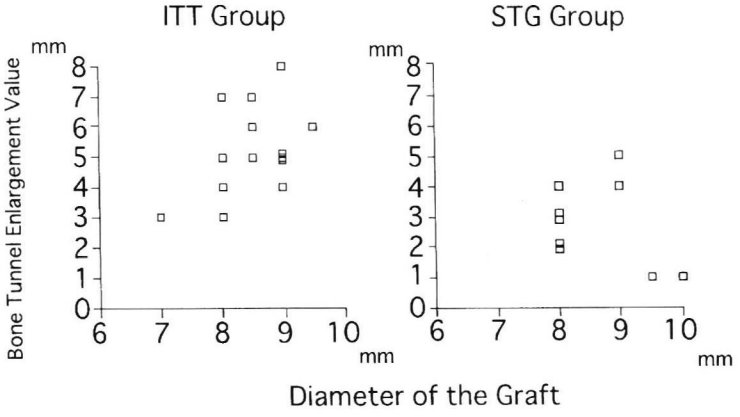


Fig. 4 Diameter of the graft and bone tunnel enlargement value

unclear−margin type.

Both intra−and extra−articular reconstruction was performed in the ITT Group, in contrast to simple intra−articular reconstruction in the STG Group. The difference in the operative methods may have caused a biomechanical difference between the two groups. In the ITT Group, lateral tenodesis was made using distally pedicled iliotibial tract and fixed at the lateral opening portion of the femoral tunnel, and the graft was continued to intra−articular reconstruction through the femoral bone tunnel to distal tibial fixation. So the graft ran through in long course and was expected to stress all the femoral tunnel including the lateral side of tunnel as well as the medial portion. On the other hand, the STG Group received simple intra−articular reconstruction that was supposed to stress only the femoral bone tunnel contacting the graft including the medial opening portion. Hence, we speculate that femoral bone tunnel enlargement was related to a mechanical factor and the difference between the two groups was caused by difference in the mechanics.

Bone tunnel enlargement following anterior cruciate ligament reconstruction is a possible cause of loosening of the graft. However, no significant correlation was found between the enlargement and the postoperative stability, as already reported by several authors[2~5], thus enlargement does not appear to

affect the clinical results.

Conclusions

Femoral bone tunnel enlargement was observed following each of the two methods of anterior cruciate ligament reconstruction using either the iliotibial tract or the hamstring tendons. The ITT Group showed significantly greater enlargement than the STG Group. A mechanical factor was considered to be the main cause for the enlargement. No correlation was found between the enlargement and the stability of the reconstructed anterior cruciate ligament.

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A Case of Osteochondral Fracture in the Lunate

月状骨に生じたOsteochondral Fractureの治療経験

Yukio Horiuchi 堀内 行雄[1)]
Yasushi Nakao 仲尾 保志[1)]
Tsuyoshi Takeda 竹田 毅[2)]
Shinichirou Takayama 高山真一郎[1)]
Kou Masumoto 増本 項[2)]
Yutaka Yabe 矢部 裕[1)]

●Key words
Osteochondral fracture : Lunate
骨軟骨骨折，月状骨

●Abstract

We report a rare case of an osteochondral facture in the ulno-volar side of the lunate in a professional baseball player, which occurred during base sliding. Radioscopic examination suggested that the styloid of the ulna impacted on the ulno-volar side of the lunate during maximal pronation-flexion of the wrist. Surgical removal of the bony fragments alleviated wrist pain, and the patient returned to playing baseball at his previous level.

●要旨

月状骨の通常骨折の生じにくい部位にosteochondral fractureをきたした症例を経験した。症例は，右投右打の30歳プロ野球一軍内野手で手掌をついてヘッドスライディングし，2塁ベースに左手背が押しつけられ体重がのり，左手関節が掌屈かつ尺屈強制された。12週後，疼痛が緩和せず来院した。

手関節を掌屈し回内・尺屈すると疼痛が生じ，月状骨の掌・尺側に圧痛が存在した。X線上，月状骨にosteochondral fractureによる遊離骨片を認めた。透視下で手関節を掌屈し尺屈・回内すると尺骨茎状突起が月状骨の骨片の母床に近接するのが観察され，その間に骨片がはさまり疼痛を生じていた。骨片摘出手術により症状は改善し，一軍に復帰した。

堀内行雄
〒160-8582 東京都新宿区信濃町35
慶應義塾大学医学部整形外科学教室
TEL 03-3353-1211

1) Department of Orthopaedic Surgery, School of Medicine, Keio University
2) Department of Sports Clinic, School of Medicine, Keio University

Introduction

A fracture in the lunate is rare, representing perhaps 1.1 % of all carpal bone fractures[1]. Teison[2] reported an incidence of 0.5 %, and Sasaki[3] 1.6 %. An osteochondral fracture in the lunate is extremely rare. Here we report such a fracture involving the ulno-volar side of the lunate in a professional baseball player, and discuss the pathogenesis of this fracture.

Case report

A 30-year-old professional baseball player in the position of shortstop, twisted his left wrist when sliding headfirst into second base in a baseball game. His wrist was strongly flexed and hyperpronated at the corner of the base, and his body weight was pressed to the dorsal side of his left hand. He felt pain immediately on the ulnar side of his wrist, which became swollen. He consulted his team doctor who told him that the radiographs showed no fracture. He was treated for a wrist sprain, but was unable to return to playing baseball for a period of three months. He then consulted our clinic for evaluation.

On examination, he presented no crepitus, no swelling, and no local heat in the wrist, but the active range of motion of his wrist was limited by pain. He felt pain during maximal pronation-flexion of his left wrist and tenderness in the ulno-volar side of the wrist. Radiographs revealed a dislocated osteochondral fracture on the ulno-volar side of the lunate (Fig. 1). Under radioscopic examination, we observed that the styloid of the ulna was close to the ulno-volar side of the lunate and that bony fragments were interposed between these two bones during maximal pronation-flexion of the left wrist (Fig. 2).

We performed an operation to remove the bony fragments. A 2 cm transverse incision was made proximal to the wrist flexion crease. Three fragments were removed along with the synovium (Fig.

Fig. 1 Radiograph showing the dislocated osteochodral fracture in the ulno-volar side of the lunate, at three months after the injury.

Fig. 2 Radiograph showing the styloid of the ulna close to the ulno-volar side of the lunate, and bony fragments interposed between these two bones in the maximal pronation-flexion position of the left wrist under radioscopic examination.

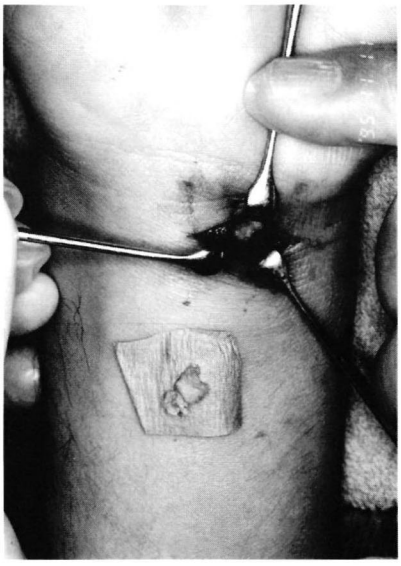

Fig. 3 Operative findings. A 2 cm transverse incision was made proximal to the wrist flexion crease. Three fragments were removed with the synovium. The size of the largest fragment was 5×5×6 mm.

3). The size of the largest fragment was 5×5×6 mm. After the operation, the wrist was immobilized for 10 days, following which the patient was allowed gentle range-of-motion activity. At 6 weeks after the operation, he was allowed to exercise that simulating batting motion. At 2 months after the operation, the motion of his wrist was almost normal for both active and passive ranges of motion, and he had achieved good recovery of grip strength. Then he rejoined his team for baseball training, and he was able to play professional baseball at his previous level throughout the next pennant race.

Discussion

A fracture in the lunate is rare, and reported cases have been discussed mostly in relation to lunomalacia. Sasaki et sl.[3] reported 5 cases of a lunate body fracture in a series of 318 cases of a carpal bone fracture. In that series, the source of all the dorsal chip fractures in the carpal bone was not in the lunate but in the triquetrum. We concurred that a fracture in the lunate is rare and, in particular, a solitary osteochondral fracture in the lunate is extremely rare.

Teison[2] reported 17 cases of a fresh lunate fracture. He classified these fractures into five groups according to the radiological appearance and the vascular anatomy of the lunate. The present case would be in Group II of his classification, and resembled two cases in his series. Group II was defined as a chip fracture that did not affect the main blood supply.

An osteochondral fracture in the lunate in this case occurred under unusual conditions, combining maximal pronation-flexion of the wrist and a single large force when sliding headfirst into a base. Radiographs showed a dislocated osteochondral fracture in the ulno-volar side of the lunate. Under radioscopic examination, the styloid of the ulna appeared close to the ulno-volar side of the lunate during maximal pronation-flexion of the wrist. Therefore, we believe that the styloid of the ulna impacted on the ulno-volar side of the lunate in the pronation-flexion position.

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Incidence of Adverse Effects by Cold Application after Athletic Injury—Four Cases of Frostbite which Developed after Cold Application : The Need for Prevention Education

スポーツ傷害後のアイシングによる弊害とその予防
—アイシングによって発症した凍傷の4例—

Toshiharu Yamamoto 山本 利春[1)] Takanori Yoshinaga 吉永 孝徳[2)]
Keizo Sakamoto 阪本 桂造[3)] Etsuo Fujimaki 藤巻 悦夫[3)]

● Key words
Icing : Frostbite : Sports injury
アイシング，凍傷，スポーツ傷害

● Abstract
The application of ice is a widely accepted method for emergency treatment of acute athletic injuries. However, the issues involved in this therapy are not yet well recognized under the present circumstances. Recently, we have experienced 4 cases of frostbite which developed after such cold application treatment. In all the patients, the cold product used on the injury was either deep-frozen ice cubes or commercially-available chemical cold packs frozen in a freezer, instead of ice cubes at 0℃ produced by an ice-making machine. Since no patient received excess compression or long-term cold application, the cause of the frostbite was attributed to the excessively-low temperature of the deep-frozen cold product used for the therapy. Since few Japanese athletic facilities have ice-making machines installed at the athletic field, deep-frozen stored ice or commercial cold packs frozen by a freezer are used frequently for emergency care. In view of the above, it is essential to pay close attention to the actual temperature of the cooling material. It is concluded that widespread dissemination of accurate information is needed about how to apply cold packs, in particular to avoid skin contact with deep-frozen material, to prevent occurrence of secondary injuries such as frostbite.

山本利春
〒299-5295 千葉県勝浦市新官841
国際武道大学体育学部
TEL 0470-73-4124

1) Faculty of Physical Education, International Budo University
2) Recruit Seagulls
3) Department of Orthopaedic Surgery, Showa University School of Medicine

●要旨

アイシングは，スポーツ外傷後の応急処置として広く普及しているが，その弊害や留意点についての十分な認識が得られていないのが実状である。今回，われわれはアイシングによって生じた凍傷の4症例を経験した。発症時に用いられた冷却物は全例製氷機の氷ではなく，家庭用冷蔵庫でつくられた氷やコールド・パックであった。過度な圧迫や長時間の冷却は行っていなかったことから，使用した冷却物の温度が過度に低くなっていたことが原因であると考えられた。日本では，スポーツ現場に製氷機が設置されている例が少ないため，家庭用冷蔵庫で冷凍された氷やコールドパックを利用するところが多いが，冷却温度に十分注意することが必要であることが示唆された。アイシングの正しい知識を普及し，凍傷などの二次的な障害を予防することが重要であると思われた。

Introduction

Cold application, which has been considered effective as an emergency measure after athletic injury, is currently in widespread use[1]. However, the cold application used on-site at the athletic field is still associated with the problem of secondary injuries, such as frostbite, occurring in a substantial number of cases. We have recently experienced 4 patients with frostbite, which developed after cold application treatment, and obtained some useful findings on the underlying cause of the frostbite in these cases. In this report, from the viewpoint of prevention, we highlight the critical points when using cold application therapy for injury.

Cases

Case 1(Fig. 1) : This case is of a 22-year-old female Judo player and an Olympic candidate who developed an inversion ankle sprain while exercising at a training camp. While the athlete was squatting down due to shock and pain due to the injury, a coach who was in attendance nearby applied and fixed a commercially available deep-frozen cold pack, which had been stored in a freezer at the Judo rink, directly in skin contact on the injured site. Although the period of time until a trainer was aware of this fact and removed the ice pack was only 5 minutes, she had developed frostbite. Taping was impossible at the training site because the upper lateral

Fig. 1 Case 1

Fig. 2 Case 2

Fig. 3 Case 3

malleolus was involved by the frostbite over a wide area.

Case 2(Fig. 2) : This case is of a 20-year-old college male Judo player who felt pain in the popliteal area during training. Without consultation, he applied and fixed a deep-frozen cold pack in skin contact to the affected site for about 10 minutes using a bandage after the completion of training. He developed blistering the next day.

The cold packs used in both Cases 1 and 2 were deep-frozen cold chemical packs which had been stored in a freezer for a long period.

Case 3(Fig. 3) : This case is of a 19-year-old college male long jump athlete who developed a hamstring muscle strain during a competition. Since no fresh ice was available at the athletic field, deep-frozen stored ice cubes were obtained from a freezer and placed inside a plastic bag and then fixed to the

Fig. 4 Case 4

affected site in very close but not direct contact, using an elastic bandage. He fell asleep due to physical fatigue, with the deep-frozen ice bag still attached. At about 30 minutes later, he developed frostbite. This patient was at the time participating in a local preliminary contest for the National Athletic Meeting together with several other athletes, and primary care was administered by his colleagues.

Case 4(Fig. 4) : This case is of an 18-year-old college female long-distance runner who developed an inversion ankle sprain while running on turf. She was treated for about 20 minutes with a cold application using fresh ice made by an ice-making machine at the athletic ground by her trainer. There was no abnormality at the icing site at that time. She was instructed to continue to apply the same cooling treatment. However, at home she subsequently used ice produced and stored in deep-freezer and, consequently, developed frostbite. About 5 weeks were required for complete healing.

These four cases are summarised in Table 1.

Discussion

The underlying causative factors for developing frostbite appear to include the cooling temperature, the duration of application, and degree of compression[2, 3]. In the four patients described in this report, deep-frozen cold chemical packs were used in 2 cas-

Table 1 Case Summary.

<Case 1> A 22-year-old female Judo player and Olympic candidate.	
Injury	Right ankle inversion sprain
Cooling material	Commercially-available deep frozen cold pack which had been stored for a long period in a freezer. It was applied directly onto the affected site.
Application time	About 5 minutes
Compression	Fixation using a towel with mild compression force
Frostbitten site	Right lower leg
Recovery period following frostbite	3 weeks

<Case 2> A 20-year-old male college Judo player.	
Injury	Right knee joint pain
Cooling material	Commercially-available deep frozen cold pack which had been stored for a long period in a freezer. It was applied directly to the skin of the affected site.
Application time	About 10 minutes
Compression	Fixation using a bandage with mild compression force.
Frostbitten site	Right knee popliteal area
Recovery period following frostbite	3 weeks.

<Case 3> A 19-year-old male college long jumper.	
Injury	Right hamstring muscle strain
Cooling material	Deep-frozen Ice cubes packed in a plastic bag
Application time	About 30 minutes
Compression	Fixation using an elastic bandage with mild compression force
Frostbitten site	Right hamstring
Recovery period following frostbite	4 weeks

<Case 4> An 18-year-old female college long-distance runner.	
Injury	Left ankle inversion sprain
Cooling material	Deep-frozen ice cubes packed in a plastic bag
Application time	About 20 minutes
Compression	Fixation using an elastic bandage with mild compression force
Frostbitten site	Left lower leg
Recovery period following frostbite	5 weeks

es and ice cubes stored in a deep-freezer were used in the other 2 cases. The application time ranged from 5 to 30 minutes. None of these patients received noteworthy compression.

In general, first-aid guidebooks recommend repeated cold applications over 24 to 48 hours, with each application lasting from 10 to 30 minutes, depending on the severity of the injury (Table 2). However, as observed in the present cases, an excessively cold temperature of the cooling material is liable to cause frostbite within a very short time[3, 4]. Ice cubes or cold packs frozen and stored in a freezer are cooled to a temperature below 0℃. Depending on the specifications of the freezer, the temperature is adjustable down to −20℃ at the lowest. This means that the temperature of the cooling material used for cold application treatment can be too cold, depending on the preset temperature of the freezer. In the present series, frostbite developed in each case due to the excessively cold temperature of the ice cubes or chemical cold packs stored in a deep-freezer.

According to Knight[3], direct application of ice packs is unlikely to cause frostbite if the application time is less than one hour. However, this only applies to an environment (as in the United States) where

Table 2 Cold application times proposed by various investigators. Extracted from various articles describing how to apply cold (icing method) found in Japanese books or journals.

Kawano	(1986)	10~15
Ork	(1981)	12
Shiraki	(1987)	10~15
Iwasaki	(1986)	12~15
Knight	(1985)	15~20
Uozumi	(1982)	15~20
Minishima	(1986)	20
Kigawa	(1987)	20~30
Okazaki	(1992)	30
Yoshida	(1988)	30
Koyanagi	(1992)	15~20

(unit = minutes)

Table 3 Place or means of primary care after athletic injury subjects of the survey by questionnaire were 282 collegiate athletes. The survey was limited to those subjects with an ankle joint sprains.

Self-treatment	63.1%
By bone-setter	14.5%
By coach or club member	8.9%
At hospital	8.5%
By trainer	6.4%
At school health control center	3.5%

fresh ice cubes are produced by an ice-making machine, and are at about 0℃ (Fig. 5). In an environment like Japan where few ice-making machines are available at athletic fields, ice produced in a freezer is more likely to be used, thereby requiring

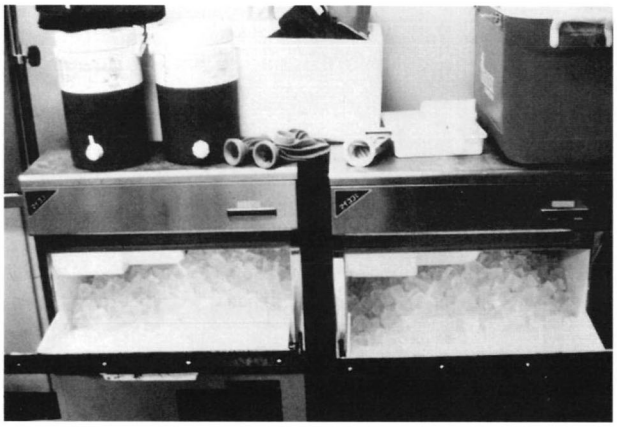

Fig. 5 Ice making machine

extreme caution in evaluating the type and temperature of the cooling material.

Table 3 lists the results from a questionnaire administered to 282 collegiate athletes about the method of primary care after injury. Self-administered primary care was the most common, accounting for 63 % of the replies. In all four patients of the present series, the cold application treatment that led to the development of frostbite was performed by the patient, or by another athletes person in attendance nearby, rather than by the trainer or a doctor. As discussed above, in the present Japanese situation, since primary care is self-administered by the player, or administered by another athlete or the trainer nearby, then widespread dissemination of accurate information on cold application treatment, beyond trainers and doctors, is important.

Table 4 lists the preventive measures against frostbite occurring after cold application treatment. With respect to the cooling time in particular, one suggested option is that cooling is not conducted by setting a

Table 4 Future preventive measures

1. Based on the sensation at the applied site, and not based merely on the application time.
2. Installation of ice-making machines at athletic fields.
3. Add water to the ice pack or avoid applying it directly to the skin if the cooling material's temperature is too low.
4. Provide athletes with more accurate knowledge about cold application treatment.

given time based on a textbook ; instead, when the cooled site becomes numb, the ice should be removed for a while[5]. This can be done by referring to the sensation when cooled as the criterion. Other preventive measures include the installation of ice-making machines at as many athletic fields as possible and recognition of the correct method of basic cold application as primary care by every player and coach.

The effectiveness of icing as emergency care for cold application after an athletic injury is well known. It is necessary, however, to pay close attention to the temperature of the cooling material and the duration of application in order to prevent frostbite as a secondary injury.

Conclusions

1. Four cases of frostbite induced by cold application after athletic injury are presented in this report.
2. All the patients developed frostbite within 30 minutes after cold application treatment. These cases clearly demonstrated that even an application time of 10 to 30 minutes, was sufficient to cause frostbite.
3. Ice cubes and chemical cold packs frozen and stored in a deep-freezer have an excessively low temperature, and thus present a risk for frostbite within a relatively short period of application.
4. It is recommended that more accurate information about cold application treatment be disseminated at all athletic fields.

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Sports Injuries in Elite Badminton Players

一流バドミントン選手の外傷・障害特異性

Takashi Ogiuchi 荻内 隆司 Takeshi Muneta 宗田 大
Kazuyoshi Yagishita 柳下 和慶 Haruyasu Yamamoto 山本 晴康

● Key words
Sports injuries : Badminton
スポーツ外傷・障害，バドミントン

● Abstract

To evaluate the characteristics of badminton injuries in high-level players, we have reviewed 138 injuries reported by all the 41 players who have been Japanese Olympic nominees since 1989. We investigated the location, the type of injury, and the correlation with the dominant-arm side.

In this study, we found a high incidence of all of the following : i) chronic disorders in the dominant arm, ii) traumas or disorders around the knee on the dominant-arm side, iii) traumas or disorders in the foot or ankle on the opposite arm side, iv) lumbar disorders, and v) anemia or menstrual disorders in female players.

● 要旨

バドミントンのオリンピック強化指定選手41名の外傷と障害を既往も含めて調査した。その部位，種類および利き手との関連を検討し，競技の特異性からその原因を考察した。41名中39名に何らかの外傷，障害歴が合わせて138件あり，そのうち運動器の外傷，障害が111件(外傷が32件，障害が79件)認められた。今回の調査では利き手側の上肢の障害，利き手側の膝周囲の下肢の外傷と障害，非利き手側の足および足関節の外傷と障害，腰部障害が多かった。整形外科的障害以外では女性の貧血と月経異常が多く認められた。

荻内隆司
〒113-8519 東京都文京区湯島1-5-45
東京医科歯科大学医学部整形外科学教室
TEL 03-5803-5279/FAX 03-5803-5274

Department of Orthopaedic Surgery,
Tokyo Medical and Dental University, School of Medicine

Introduction

Badminton as a recreational sport is popular, easy to play, and relatively safe. Badminton as a competitive sport, however, demands hard footwork and a lot of exercise, so injuries are more common than expected[1~3]. Many leading players regularly compete with some degree of injury. Most players in competitive levels have been playing badminton since their pre- or low-teens, so they are apt to develop chronic disorders.

Badminton has been an officially-approved Olympic sport since 1992. We have investigated the trends of trauma or injury in Japanese Olympic badminton athletes. There are few studies that accurately show the incidence of injuries in elite badminton players[1, 4]. We have identified several characteristic injuries in badminton players by investigating the traumas and disorders in these players.

Materials and methods

In this study, we have investigated all 41 players (18 male, 23 female) who had been nominated to be Olympic representatives. The average age of the players, at the time of their first consultation was 21.8 years, and the average age at which they had started competitive badminton was 10.3 years. For male players, the average height was 175 cm, weight 70 kg, and age was 24.5 years. For female players, the average height was 164 cm, weight 58 kg, and age was 21.9 years. There were 4 high-school players, 9 college or junior college players, and 28 company amateur players at the time when they were first nominated. The average practice time per week was 23.3 hours (range from 15 to 36 hours). The practice time of female players tended to be longer than that of male players. Five of the 41 players were left-handed players.

We questioned the Olympic nominees regarding badminton-related injuries that they had received prior to their nomination, and checked their medical records from 1989 to 1995. We examined the anatomical location and the type of injury and the correlation to the player's dominant-arm side. In this report, we will be referring to the Dominant-Arm Side as the DAS, and the Opposite-Arm Side as the OAS.

Results

We counted those injuries that were sufficiently severe to affect their training or playing ability and also those that needed a consultation and/or medical treatment by a doctor.

We found that 39 (95 %) of the 41 players had had some kind of injury. The total number of injuries was

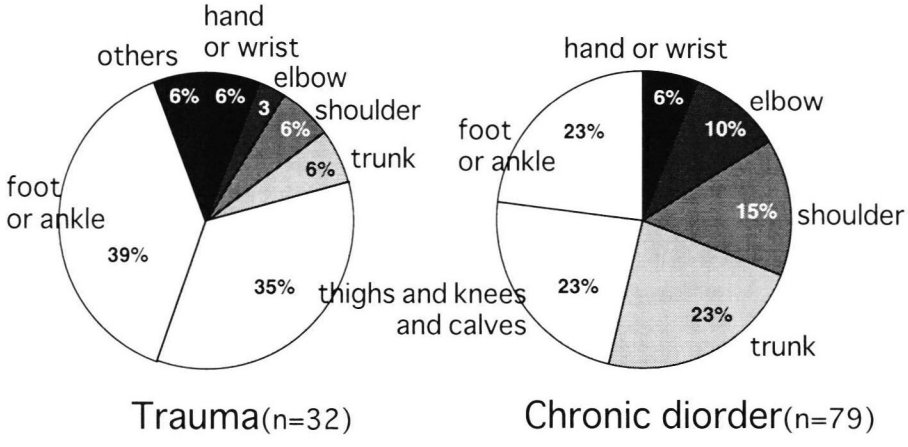

Fig. 1 Classification of injury by location

Table 1 Location and Diagnosis of Injuries : correlation with the dominant-arm side

Location and Diagnosis	Trauma	DAS	OAS	Disorder	DAS	OAS
Hands or Wrists	Fracture in the Lunate	1		Disorder in the TFCC	2	
	Bruise on the thumb	1		Kienboeck's disease	1	
				Tendinitis	1	
				Peripheral vascular disorder	1	
Elbows	Ulnar fracture		1	Lateral epicondylitis	4	
				Medial epicondylitis	2	
				Extension loss	1	
				Entrapment neuropathy	1	
Shoulders	Rupture in the supraspinatus	1		Overuse syndrome	7	
	Clavicula fracture	1		Tendinitis in the rotator cuff	3	
				Bennet lesion	1	
				Loose shoulder	1	
Trunk	Rib fracture	2		Chronic lumbago	11	
				Lumbar spondylolysis	4	
				Lumbar disc herniation	1	
				Others	2	
Thighs, Knees or Calves	Muscle damage to hamstrings	3	1	Jumper's knee	6	1
	ACL injury	1		Osgood-Schlatter disease	2	
	PCL injury		1	ITT friction syndrome		1
	MCL injury	2		Chondromallacia in the patella		1
	Meniscus injury	1		Stress fracture in the patella	1	
	Bruise on the knee	2		Stress fracture in the tibia	1	1
				Shin splint		1
				Chronic compartment syndrome	1	
				Others	1	1
Feet or Ankles	Lateral ligament injury	2	2	Achille's tendinitis	1	4
	Ankle sprain	1	3	Plantar fascitis	1	3
	Metatarsal fracture		2	Heel pain	1	3
	Ankle fracture		1	Chronic metatarsal pain	2	1
	Ankle pain		1	Arthritis in the MTP joint	1	
				Impingement exostosis	1	
Others			2			

138. Of these, 111 were orthopaedic injuries, consisting of 32 cases of trauma and 79 of chronic disorder. The average number of orthopaedic injuries (including traumas and chronic disorders) per person was 2.7. Of the remaining injuries, anemia or menstrual disorders in female players were most common.

The distribution of the anatomical location of the traumas and disorders is shown in Fig. 1. The percentage location of a trauma in the hand or wrist was 6 %, in the elbow 3 %, shoulder 6 %, trunk 6 %, thigh, knee or calf 35 %, foot or ankle 39 %, and others was 6 %. The percentage of chronic disorders in the hand or wrist was 6 %, elbow 10 %, shoulder 15 %, trunk 23 %, thigh, knee or calf 23 %, in the foot or ankle was 23 %.

We examined the typical traumas and disorders in each anatomical location and have presented typical or characteristic cases(Table 1, Fig. 2).

There were 2 cases of trauma and 5 cases of disorder found in the hand or wrist. All these were in the DAS. A fracture in the lunate had occurred when hitting the shuttle. Fig. 3 shows Kienböck's disease in a 24 years-old male player. We can see sclerosis in the lunate and ulnar minus variant. The player able to continue playing badminton with conservative treatment.

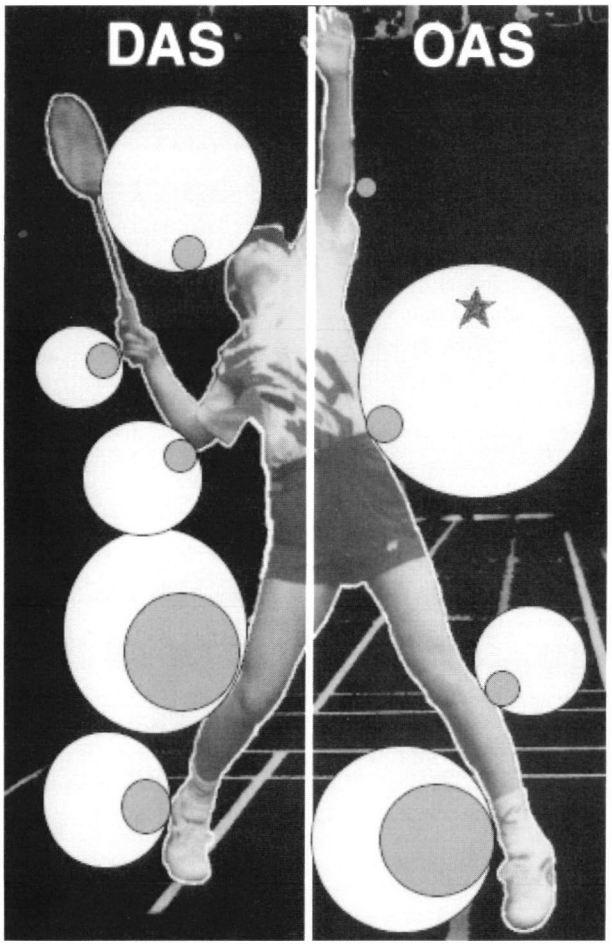

Fig. 2 Location and number of injuries : correlation with the dominant-arm side (DAS). OAS means the opposite side of the dominant arm. The size of the circle represents the number of injuries. ● : Acute trauma, ○ : Chronic disorder. ★ : As this is a trunk injury, it is difficult to determine if the injury occured in the DAS or OAS.

There was 1 case of trauma and 8 cases of disorder found in the elbow. Only one case of an ulnar fracture suffered in a fall was found in the OAS.

In the shoulder, all traumas and disorders were in the DAS. There were 2 cases of trauma and 12 cases of disorder. Almost all disorders were caused by repetitive overhead strokes in training.

In the trunk, the number of cases of lumbar spondylolysis was remarkable.

Muscle damage to the hamstrings and knee ligament injuries in the DAS were most common among cases of trauma in the lower extremities, except feet and ankles. Fig. 4 shows a stress fracture in a 24 years-old female player. The roentogenogram shows the fracture line (arrow), with hypertrophy in the anterior cortex of the tibia.

The total number of traumas in the foot or ankle was 12. Ankle sprains and lateral ligament injuries, both in the OAS, were the most common. Most cases were treated conservatively. The total number of disorders in the foot or ankle was 18. We found many cases of plantar fascitis, and of Achilles tendinitis, in the OAS.

Five female players had anemia (Hb<12) caused by hard and excessive training. The Hb level in the most serious cases was at 7.2. All these players were diagnosed with iron deficiency anemia, and two had already been prescribed iron tablets for anemia. Eight female players had or had had a menstrual

Fig. 3 Kienböck disease in a 24 y.o. male player

abnormality or athletic amenorrhea.

Discussion

We found that the most frequent injuries in top-level players were chronic disorders due to accumulated stress from over-training, whereas the reported injuries in recreational level players were acute traumas due to irregular training[1, 4]. In this study, we found a high incidence of chronic disorders in the DAS upper extremity, traumas and disorders around the knee in the DAS, traumas and disorders in the foot or ankle in the OAS, and lumbar disorders. The main reason for their injuries was over-use. Elite badminton players in Japan usually begin to practice badminton in their childhood and chronic disorders such as Osgood's disease or lumbar spondylolisis frequently occur during the growth period of adolescence.

With regard to female players, there was a surprisingly high percentage of menstrual abnormalities and/or anemia similar to that found in long-distance running athletes. The high incidence of hormonal and nutritional imbalances may increase the risk of stress fracture[5]. The reason why such a high percentage of female players experience menstrual disorders may be due to extensive training time (generally longer than their male counterpart) and the high quantity of physical training such as running.

Badminton is a sport which requires hard footwork in a narrow court and repetitive over-head strokes of a light shuttle using a light racket. Therefore injuries in the dominant arm were frequent[4].

In tennis players, lateral disorders in the elbow may occur by repetitive back-hand strokes. In badminton players, such disorders may occur due to insufficient forearm muscle power or by insufficient stretching exercises before playing. Medial disorders in the elbow were more common than in tennis players and often occurred in players who were powerful 'smashers' or those who had unusual style[6].

This study found very few severe shoulder and elbow injuries compared with past reports[1, 6]. This may be because few players with irregular form or players who suffered such severe injuries have reached this Olympic level of competition.

Fig. 4 A stress fracture in the tibia of a 24 y.o. female player

Repetitive over-head stroke playing like 'high-clear shots' or 'smashes' is more frequent in badminton many than in other racquet sports. This causes intensive flexion and extension of lumber spine which finally leads to these kind of stress fractures.

Injury to the lower leg frequently occurs when a player is forced to receive a short forward shot in one step. Therefore, injuries occur in the players' DAS leg[4].

Almost all players had experienced an uncountable number of ankle sprains and lateral ligamentous injuries to the ankle. This happened because ankles were apt to sprain when players landed after smashing or were forced to receive difficult shots or when

they collided with a doubles partner.

We found many cases of chronic disorders such as plantar fascitis or Achilles tendinitis in the OAS. These disorders seems to be caused by over-running and hard footwork on a solid floor. We believe there are two reasons why these disorders frequently occurred in the OAS ; i) due to stress placed on the OAS leg when stepping to receive a shot (usually one step), and ii) due to repetitive impaction at landing on the supporting leg after smashing.

We did not find any cases of Achilles tendon rupture that is common in recreational-level players nor cases of heat stroke that is frequently reported during training summer camps of school level players[1,6~8]. Moeller et al[8]. reported patients with Achilles tendon rupture had a relatively high average age, which indicates that a majority were recreational athletes, as competitive athletes are likely to be younger. Recreational athletes may be prone to injury for several reasons. Their exercise is often interrupted by periods of inactivity and preventive measures such as warming up, stretching and attention to proper technique are often disregarded due to lack of competent coaching.

From this study we draw the following conclusions. In order to decrease the number of sports injuries in elite badminton players, i) In young players during the years of physical development, excessive over-head stroke playing in practice sessions should be avoided. ii) Quality training shoes with shock absorbent soles should be worn. iii) Excessive time spent doing physical fitness training, in the case of female players, is not recommended. Female players are advised to have regular health checks to monitor bone mineral density and menstrual disorders which of ten lead to stress fractures.

Conclusion

We have reported on sports injuries (including traumas and chronic disorders) in elite badminton players.

We have found a high incidence of all of the following : i) a chronic disorder in the dominant-arm, ii) a trauma or disorder around the knee in the dominant-arm side, iii) a trauma or disorder in the foot or ankle in the opposite-arm side, iv) a lumbar disorder, and v) anemia or menstrual disorder in female players.

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Early Postoperative Athletic Rehabilitation Program for Muscle Strengthening after Anterior Cruciate Ligament Reconstruction

膝前十字靱帯再建術後早期のアスレチックリハビリテーションによる筋力改善効果の検討

Atsushi Mori 森 淳 Yasumasa Shirai 白井 康正
Yoshihito Nakayama 中山 義人 Tetsuya Narita 成田 哲也
Norishige Iizawa 飯沢 典茂 Hidetoshi Hayashi 林 英俊

● Key words
Anterior cruciate ligament : Rehabilitation : Muscle strengthening
前十字靱帯，リハビリテーション，筋力強化

● Abstract
We have investigated the efficacy of an athletic rehabilitation program, which laid emphasis on muscle strengthening through rapid movements, in the early postoperative recovery of muscle strength after anterior cruciate ligament reconstruction. A total of 19 athletes who followed this program postoperatively were studied. Isokinetic muscle strength tests were completed before and after this program at 60, 120, 180, and 240 deg/sec angular velocity with a CYBEX 6000 dynamometer. Peak torque was improved significantly at each angular velocity in both extensor and flexor muscle strength, and the improvement ratio of peak torque in extensor muscle strength at fast angular velocity (180 or 240 deg/sec) was significantly higher than that at slow angular velocity (60 or 120 deg/sec). It was concluded that this program was effective for athletes who wished to achieve a quick return to their pre-injury level of sports activity after anterior cruciate ligament reconstruction.

● 要旨
速いスピードの運動における筋力を重要視したアスレチックリハビリテーションプログラムが膝前十字靱帯再建術後早期の筋力回復に及ぼす効果を検討した。対象は術後に本プログラムを施行した19例の競技選手である。CYBEX 6000を用いて本プログラム期間前後に等速性筋力測定を60，120，180，240°/秒の角速度で行った。伸展筋力・屈曲筋力ともピークトルクはそれぞれの角速度で有意に増大し，伸展筋力で高速(180，240°/秒)の角速度におけるピークトルクの改善率が低速(60，120°/秒)の角速度に比べて有意に高かった。本プログラムは膝前十字靱帯再建後に元のスポーツ活動への復帰をめざす競技選手にとって速い動作の再獲得に有用と結論された。

森 淳
〒113-8603 東京都文京区千駄木1-1-5
日本医科大学整形外科学教室
TEL 03-3822-2131 内線6754

Department of Orthopaedic Surgery,
Nippon Medical School

Introduction

Anterior cruciate ligament (ACL) injuries are common in young athletes, and such lesion may preclude continued participation in sports activities. The goal of treatment and rehabilitation after an ACL injury should be to regain the pre-injury level of sports activity ; this cannot be achieved without adequate recovery in muscle strength, even though the knee has regained good stability and a sufficient range of motion. In general, the degree of strength gain after ACL reconstruction is widely accepted as the factor most directly affecting postoperative sports activity.

A current accelerated rehabilitation program[1] appears to have overcome the delay in strength recovery which was one of the problems encountered in past rehabilitation procedures after ACL reconstruction. However, some patients with adequate muscle strength recovery, who were thought to have been fully rehabilitated by the accelerated program after successful ACL reconstruction, have expressed dissatisfaction with the quality of motor performance in their postoperative sports activity.

The increase in motor performance is another important factor influencing postoperative sports activities. Motor performance involves both specific strength and power needs. To increase motor performance, a postoperative athletic rehabilitation program that meets the sports-specific needs should be designed for athletes. A variety of competitive sports, such as basketball, soccer, and volleyball, demand quick explosive movements, and rapid jumping and turning skills are essential. To be strong in such quick movements, athletes have to train at fast speeds. To be skillful in explosive movements, athletes have to train for power. We started an early postoperative athletic rehabilitation program for athletes after ACL reconstruction which laid emphasis both on strength at fast speeds and power in 1994.

This study was designed to investigate the efficacy of our athletic rehabilitation program on the early postoperative recovery of muscle strength after ACL reconstruction. We measured the isokinetic muscle strength of knee extension and flexion at 60, 120, 180, and at 240 deg/sec angular velocity before and after this athletic rehabilitation program, using a CYBEX 6000 dynamometer (CYBEX Corp., NY, USA).

Materials and methods

1. Patient population

The selection criteria for this study were as follows : 1) a history of preoperative participation in competitive sports activities and participation in our athletic rehabilitation program after ACL reconstruction ; 2) a direct evaluation using the CYBEX 6000 dynamometer bofore and after this athletic rehabilitation program ; 3) no limitation in knee range of motion, and no pain at the time of the tests ; 4) no complex ligamentous injuries ; and 5) no history of reinjury. Nineteen patients, who had undergone unilateral ACL reconstruction with a combined semitendinosus tendon-gracilis tendon autograft augmented with woven polyester (Leeds-Keio Artificial Ligament, Neoligament Inc., Leeds, UK)[2] between December 1994 and May 1996, fulfilled the selection criteria. There were 8 male and 11 female patients with an average age of 23.6 years (with age ranging from 16 to 34 years). Ten patients had an associated meniscal tear ; five medial and five lateral. All of these had undergone a meniscectomy. The sports activities engaged in by the nineteen patients included basketball (9), soccer (4), volleyball (2), skiing (2), and tennis (2).

2. Operative procedure

All operations were performed using an arthroscopically-assisted procedure[3]. The distal 20 cm of the semitendinosus tendon and of the gracilis tendon were harvested through a small incision anteriorly and were doubled or quadrupled up with absorbable sutures. Woven polyester was sutured tightly around

Table 1 The athletic rehabilitation program protocol after ACL reconstruction (1994 through 1996)

[1] CKC training
a. Squat : 2 weeks ➡
b. KBW (knee-bended walking)
1 Forwards
2 Backwards
3 Side
4 Stop
5 Up and down a staircase
6 In a figure-of-eight
7 In zigzags
8 Turn
c. Pivot
1 Forward
2 Backward
3 Side
4 Cross step
5 One-leg pivot
d. Lifting
Step 1 : 8 weeks ➡
1 Squat
2 Three-quarter squat
3 Split squat
4 Calf raise
Step 2
1 Combination calf raise
2 Leg lunge
3 Side lunge
4 One-leg squat
5 Up a step
Step 3 : 4 months ➡
1 Squat jump
2 Flying split
3 One-leg split jump
4 High clean

[2] Jogging : 8 weeks ➡

[3] Jump training
a. Light jump : 8 weeks ➡
1 Jumping rope
2 Squat jump
3 Forward jump
4 Backward jump
5 Side jump
6 Target jump
b. Combination jump : 3 months ➡
1 Running → Forward jump → Stop
2 Running → Side jump → Stop
3 Contact jump
c. Plyometric jump : 5 months ➡
1 Tack jump
2 Standing long jump
3 Depth jump
4 Bounding

[4] Agility training
Step 1 : 8 weeks ➡
1 Short-distance jogging → Stop
2 Running in a figure-of-eight
3 Backwards running
Step 2 : 3 months ➡
1 Side step
2 Carioca (lateral crossover running)
3 Backwards step
4 Running in zigzags
5 Short-distance dash → Stop
Step 3 : 5 months ➡
1 Running → Stop → Turn
2 Turn dash
3 Sport-specific training

Return to sports activities
Practice : 5 months ➡
Participation : 9 months ➡

the doubled or quadrupled semitendinosus-gracilis tendons to make a composite graft with a diameter of 8 mm or more. The intraoperative measurement of graft isometry was performed using our custom-made isometer[4]. The graft was passed through the tibial and femoral tunnels, and was fixed with double staples in a belt-buckle fashion to both the femur and the tibia. After fixation of the graft, the knee was put through a full range of motion to ensure proper tightness of the graft. A notch plasty was performed if the graft impinged on the intercondylar notch.

3. Medical postoperative rehabilitation program

A functional knee brace allowing freedom for a full range of movement was applied immediately after the operation. On the second postoperative day, range of

motion exercises on a continuous passive motion device together with isometric muscle exercises were begun. Active range of motion exercises and partial weight bearing were allowed at 1 week after surgery, and full weight bearing and closed-kinetic-chain exercises were started at 2 weeks. The functional knee brace was removed at 8 weeks, though it was still used during sports activities.

4. Athletic rehabilitation program, 1994 through 1996 (Table 1)

A total of nineteen patients participated in the early postoperative athletic rehabilitation program from 8 weeks to 6 months after their operation. This program was characterized by comparatively elaborate jump and agility training sessions and a comparatively early emphasis on the acquisition of strength during rapid movements and power. At 8 weeks after surgery, light jump training, such as jumping rope and squat jumps, was started. This was followed at 3 months after surgery by combined running and light jump training, at 4 months by lifting jump training, and at 5 months by plyometric jumps (e.g. tack jumps and standing long jumps). For agility, linear running and running in a figure-of-eight were started at 8 weeks after surgery. Side steps, Carioca (lateral crossover running), and running in zigzags were begun at 3 months after surgery, and a combination of running and turning at 5 months. A return to sports practice was allowed at 5 months after surgery, and then return to full participation in competitions was permitted at 9 months. Use of the functional knee brace was recommended during participation in athletic competitions for the first postoperative year.

5. Evaluation

Isokinetic tests were performed on the knee extensor and flexor muscles of the involved knee using a CYBEX 6000 dynamometer. These isokinetic tests were completed at 60, 120,180, and at 240 deg/sec angular velocity. The peak torque at each angular velocity was measured before and after the early postoperative athletic rehabilitation program, and then the improvement ratio of peak torque at each angular velocity was calculated.

The body weight ratio[5,6] was used to evaluate the peak torque. The body weight ratio was obtained by dividing the peak torque by the body weight and the length of the lower leg. The pre-and post-program difference in the body weight ratio was analyzed at 60, 120, 180, and at 240 deg/sec angular velocity.

The improvement ratio of peak torque is the percentage of post-program peak torque to pre-program peak torque. In this study, the four different angular velocities were divided into two groups : the 60 and 120 deg/sec velocities were placed in a slow angular velocity group, and the 180 and 240 deg/sec velocities in a fast angular velocity group. The difference in the improvement ratio between the slow and fast angular velocity groups was analyzed.

A statistical analysis of the comparison of the pre- and post-program body weight ratio at each angular velocity was performed using the paired t-test. A comparison of the improvement ratio between the slow angular velocity group and the fast angular velocity group was made using Student's t-test. A probability of less than $p = 0.05$ was considered to be statistically significant.

Results

The post-program body weight ratio of extensor muscle strength was greater than the pre-program ratio at each of the tested angular velocities. There was a significant difference between the pre-and the post-program body weight ratio of extensor muscle strength at each angular velocity (each $p < 0.001$) (Fig. 1).

The post-program body weight ratio of flexor muscle strength was greater than the pre-program ratio at each of the tested angular velocities. There was a significant difference between the pre- and post-program body weight ratio of flexor muscle

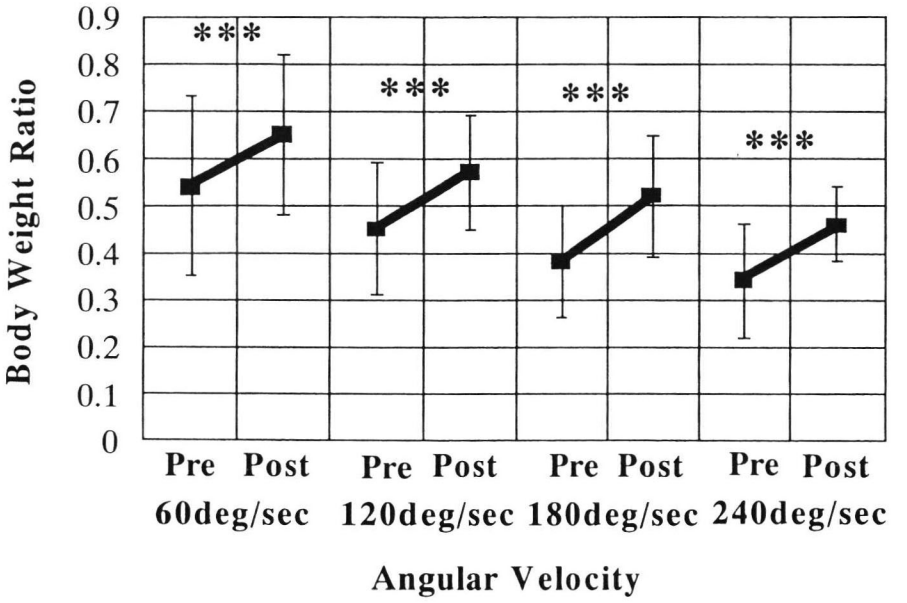

Fig. 1 The body weight ratio of the extensor muscle strength (peak torque) of the involved knee.
There was a significant difference between the pre- and post-program body weight ratio at each angular velocity (*** $p < 0.001$).

strength at each angular velocity (each $p < 0.01$) (Fig. 2).

The improvement ratio of extensor muscle strength in the fast angular velocity (at 180 or 240 deg/sec) group was greater than that in the slow angular velocity (at 60 or 120 deg/sec) group. There was a significant difference in the improvement ratio of extensor muscle strength between the slow angular velocity group and the fast angular velocity group ($p < 0.05$) (Fig. 3).

There was no statistically significant defference in the improvement ratio of flexor muscle strength between the slow angular velocity (at 60 or 120 deg/sec) group and the fast angular velocity (at 180 or 240 deg/sec) group (Fig. 4).

Discussion

Muscle strength recovery after ACL reconstruction has been studied by various groups. Marder et al.[3], in their study of patients with semitendinosus-gracilis autografts, reported that the injured-to-uninjured ratio (the percentage of injured side to uninjured side) of peak torque at 60 deg/sec angular velocity in the extensor, and in the flexor, muscle strength had recovered to 91 ± 19 %, and 83 ± 16 %, respectively, at a mean follow-up of 29 months (with follow-up ranging from 24 to 42 months) after the operation. Maeda et al.[7], also in a study with semitendinosus-gracilis autografts, reported that, at a mean follow-up of 27 months (with follow-up ranging from 24 to 42months), the injured-to-uninjured ratio of peak torque at 60 deg/sec angular velocity in the extensor, and in the flexor, muscle strength had recovered to 90 ± 17 %, and 95 ± 16 %, respectively. It has been generally accepted that these reports described good muscle strength recovery after ACL reconstruction. However, in resuming athletic activities after sports injuries, some patients, despite having acquired adequate muscle strength, take an unexpectedly long time to return to their pre-injury condition ; this is because of a lack of sport-specific strength and power. Each sport has specific strength and power needs and it is vital that postoperative ath-

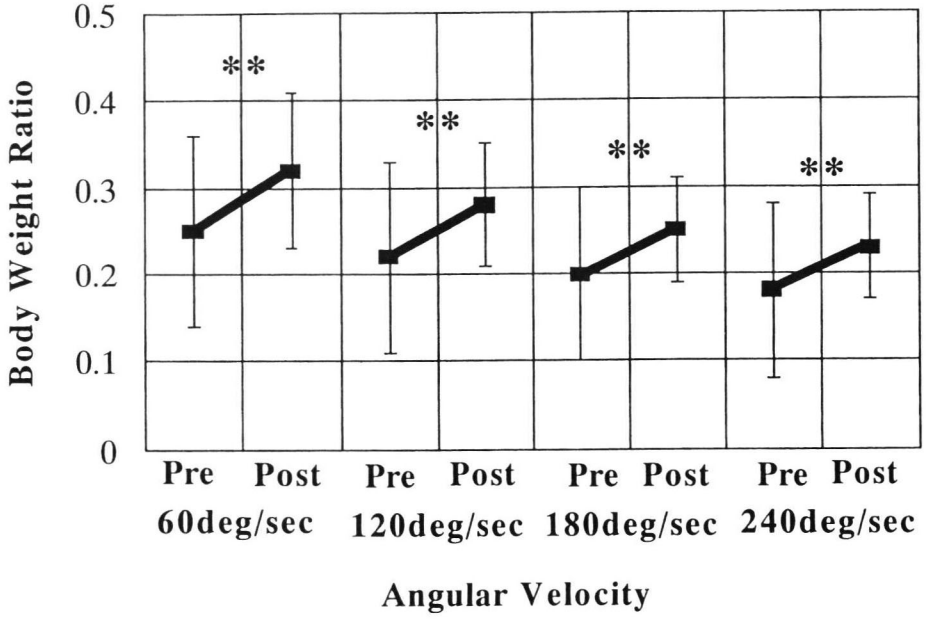

Fig. 2 The body weight ratio of the flexor muscle strength (peak torque) of the involved knee.
There was a significant difference between the pre- and post-program body weight ratio at each angular velocity (** $p < 0.01$).

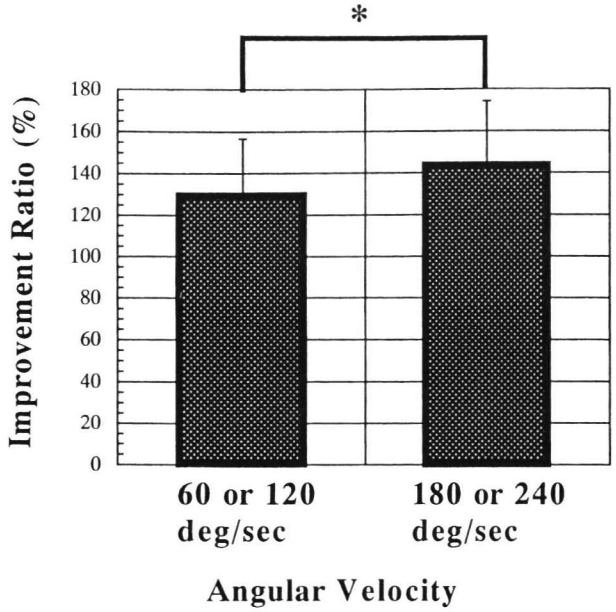

Fig. 3 The improvement ratio of the extensor muscle strength (peak torque) of the involved knee. There was a significant difference between a slow angular velocity (at 60 or 120 deg/sec) and a fast angular velocity (at 180 or 240 deg/sec) (* $p < 0.05$).

letic rehabilitation programs should be designed to meet these specific needs so that athletes can improve the quality of their motor performance. Fleck et al.[8] emphasized that careful selection of the type or combination of types of strength training was necessary before incorporating them into an athletic rehabilitation program.

Jumping and cutting sports, such as soccer, volleyball, and basketball, demand quick and explosive movements. Moffroid et al.[9] demonstrated that strength gained at fast speeds of movement carried over to all speeds of movement slower than the training speed, but that strength gained at slow speeds of movement did not carry over to speeds of movement faster than the training speed. Pipes et al.[10] reported that training at fast speeds of movement increased motor performance significantly more than training at slow speeds of movement. In addition, it is widely accepted that anaerobic training induces hypertrophic changes in fast-twitch type II muscle fibers[11]. Furthermore, Kulund et al.[12] described

how plyometric training was effective in quickly switching the neuromuscular mechanism from the lengthening phase to the contraction phase, concluding that plyometric training should be applied to all sports that demand speed and power. Narita et al.[13] also reported that plyometric drop-jump training was effective in improving the explosive eccentric force and acceleration of muscle contraction of knee extension. It is fairly clear that athletes should train at fast speeds of movement to be strong in quick movements, and that they should train for power to be skillful in explosive movements. Therefore, the athletic rehabilitation program adopted in this study was characterized by comparatively elaborate jump and agility training sessions, including plyometric training, and a comparativery early emphasis on the acquisition of strength during rapid movements and power.

In the present study, isokinetic tests were performed using a CYBEX 6000 dynamometer at 60, 120, 180, and at 240 deg/sec angular velocity, and the four different angular velocities were divided into two groups : the 60 and 120 deg/sec velocities were placed in a slow angular velocity group, and the 180 and 240 deg/sec velocities in a fast angular velocity group. On the isokinetic muscle strength testing, the range of angular velocity, at which peak torque is actually possible to be measured, have been limited. Although the 180 and 240 deg/sec angular velocities are not so high speed in comparison with the maximun angular velocity of the knee joint, the similar division of the slow and fast angular velocity groups has been widely used by previous researchers[7,13-15].

Several investigators have emphasized that muscle strength recovery after ACL reconstruction is influenced by the postoperative level of sports activities. Kikuchi et al.[15], in their study of patients with semitendinosus-gracilis autografts and a ligament augmentation device, reported that a good correlation existed between the postoperative sporting activity level and the extensor muscle strength recovery at slow angular velocity (at 60 deg/sec) on and after 9

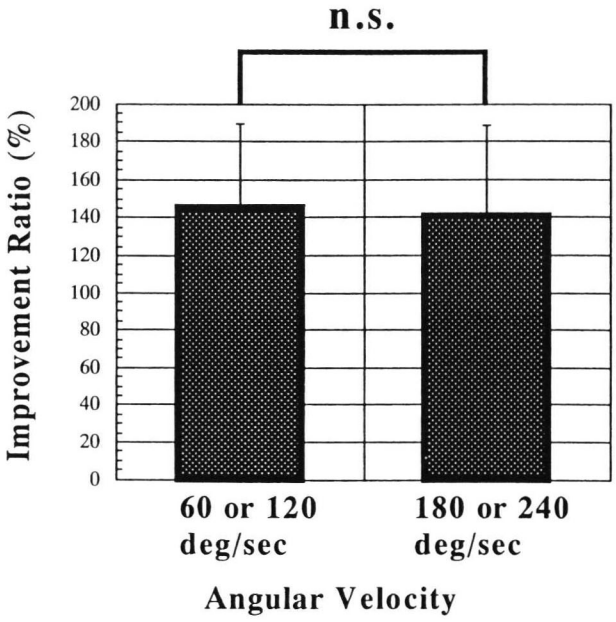

Fig. 4 The improvement ratio of the flexor muscle strength (peak torque) of the involved knee. There was no statistically significant difference between a slow angular velocity (at 60 or 120 deg/sec) and a fast angular velocity (at 180 or 240 deg/sec).

months follow-up. On the other hand, Ohkoshi et al.[16], using semitendinosus-gracilis autografts connected in series with polyester tapes, reported that the injured-to-uninjured ratio of peak torque in extensor muscle strength at fast angular velocity (at 180, 240, or 450 deg/sec) after 1 year follow-up suggested a beneficial effect of participation in athletic rehabilitation or competitive sports activities on muscle strength recovery after ACL reconstruction. However, few studies have clearly described an early postoperative athletic rehabilitation program after ACL reconstruction which laid emphasis on the development of strength at fast speeds of movement and power ; nor have the effects of athletic rehabilitation on muscle strength improvement evaluated at different angular velocities been fully clarified. In the present study, isokinetic tests were performed before and after the early postoperative athletic rehabilitation program, i.e. at 8 weeks and at 6 months after surgery. These tests were completed at four differ-

ent angular velocities. Our results showed that peak torque was improved significantly at each of the tested angular velocities in both the extensor and the flexor muscle strength, and that the improvement ratio of peak torque in the extensor muscle strength at fast angular velocity (at 180 or 240 deg/sec) was significantly greater than that at slow angular velocity (at 60 or 120 deg/sec).

The results suggested that this early postoperative athletic rehabilitation program was beneficial to developing strength in quick movements and skill in explosive movements. It was therefore considered effective for athletes, especially those engaged in jumping and cutting sports, who wished to make an early return to their pre-injury level of sporting activity after ACL reconstruction.

Conclusion

The effects of an early postoperative athletic rehabilitation program after ACL reconstruction, which laid emphasis on the acquisition of both strength at fast speeds of movement and power, were investigated by means of isokinetic testing using a CYBEX 6000 dynamometer. The improvement ratio of peak torque in the extensor muscle strength at fast angular velocity (at 180 or 240 deg/sec) was significantly greater than that at slow angular velocity (at 60 or 120 deg/sec). This athletic rehabilitation program was considered effective in promoting an early return to the pre-injury level of sports activity for athletes after undergoing ACL reconstruction.

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Reconstructed Anterior Cruciate Ligament : A Functional Evaluation in Postoperative Sports Activities Using the KT−2000 Knee Arthrometer

術後スポーツ活動における再建膝前十字靱帯の機能評価
—KT−2000による検討—

Atsushi Mori	森　淳	Yasumasa Shirai	白井　康正
Yoshihito Nakayama	中山　義人	Tetsuya Narita	成田　哲也
Norishige Iizawa	飯沢　典茂	Hidetoshi Hayashi	林　英俊

● Key words

Anterior cruciate ligament : Reconstruction : Sports activities

前十字靱帯，再建，スポーツ活動

● Abstract

To evaluate the function of the reconstructed anterior cruciate ligament in sports activities, two parameters—the anterior displacement and the anterior terminal stiffness—were measured using a KT−2000 at 134 N force. Twenty−four patients who had continued sports activities postoperatively were studied. They were divided into Group 1 (Lysholm score in sports activities of 90 points or more) and Group 2 (Lysholm score in sports activities of less than 90 points). The injured−to−uninjured difference in anterior displacement in Group 1 was smaller than that in Group 2, but there was no significant difference. The injured−to−uninjured ratio of anterior terminal stiffness in Group 1 was significantly higher than that in Group 2 ($p<0.01$). It was concluded that the anterior terminal stiffness was more useful than anterior displacement for evaluating the function of the reconstructed anterior cruciate ligament in sports activities.

●要旨

スポーツ活動における再建膝前十字靱帯の機能をより厳密に評価する目的で，KT−2000を用いて134N負荷時の前方変位量(anterior displacement : AD)と前方引き出し最終域での剛性(anterior terminal stiffness : ATS)を測定した。対象は術後スポーツ活動を継続している24例で，スポーツ活動時のLysholm score 90点以上群と90点未満群の2群に分けて検討した。AD患健側差は90点以上群では小さかったが両群間で有意差は無かった。ATS患健側比は90点以上群は90点未満群に比べて有意に高かった($p<0.01$)。スポーツ活動における再建膝前十字靱帯の機能評価には，ADよりもATSが有用と結論された。

森　淳

〒113−8603　東京都文京区千駄木1−1−5

日本医科大学整形外科学教室

TEL 03−3822−2131

Department of Orthopaedic Surgery,

Nippon Medical School

Introduction

Anterior cruciate ligament(ACL) injuries are common in young athletes, and the lesion may preclude continued participation in sports activities . The aim of treatment and rehabilitation after ACL injuries should be to regain the pre-injury level of activity. The function of the reconstructed ACL directly affects postoperative sports activities, so quantitative functional evaluation of the reconstructed ACL is important.

In general, anterior knee laxity is widely used as the optimal parameter for objective assessment of reconstructed ACL integrity, and this is measured using instruments designed to quantify the amount of tibial translation. However, some patients with good anterior knee stability, who are thought to be fully rehabilitated after successful ACL reconstruction, express dissatisfaction with their quality of postoperative sports activities in their self-evaluations.

In follow-up clinical examinations after ACL reconstruction, we examine what is called the end-point during a particular maneuver. The stiffness at the end-point measured using some instrument is an important parameter for quantitative evaluation of the reconstructed ACL. The relationship between the stiffness at the end-point and the quality of postoperative sports activity has not yet been investigated.

We therefore designed this study to evaluate critically the function of the reconstructed ACL in sports activities in the most athletically active postoperative period. We measured the anterior knee laxity and the stiffness at the end-point using a KT-2000 knee arthrometer(MEDmetric Corp., San Diego, California, USA)[1].

Materials and methods

1. Patient population

From May 1987 to June 1994, 166 patients underwent ACL reconstruction using the patellar tendon augmented with woven polyester(Leeds-Keio Artificial Ligament, Neoligament Inc., Leeds, UK)[2]. Patients not interested in sports activities (88 patients)were excluded from the study. Of the remaining 78 patients, only those that met the following selection criteria were included in the study : 1) a history of preoperative sports activities, and continued sports activities for at least eighteen months during follow-up after ACL reconstruction ; 2) a direct evaluation using the KT-2000 knee arthrometer ; 3) a healthy contralateral knee determined by the patient's history and physical examination ; 4) no history of reinjury after ACL reconstruction ; and 5)no tear in the posterior cruciate ligament. Twenty-three patients were lost to follow-up and 17 patients retired from sports activities. Ten patients were followed by means of questionaires only and not directly evaluated using the KT-2000 knee arthrometer. One patient sustained bilateral ACL tears. Three patients had failure of the ACL graft and underwent a second ACL reconstruction. Finally, 24 patients fulfilled the selection criteria. There were 14 male and 10 female patients with an average age at surgery of 23.7 years(with age ranging from 14 to 45 years). The follow-up period ranged from 19 to 105 months, with a mean of 46.8 months. The mean interval from injury to surgery was 13.6 months. Five patients had an associated meniscal tear ; three had a medial tear, and two a lateral tear. All five had undergone a meniscectomy. The sports activities engaged in by the twenty-four patients included basketball(6), volleyball(3), skiing(3), rugby(3), soccer(2), tennis(2), baseball(1), badminton(1), athletics(1), gymnastics(1), and motor sports(1). Fifteen of them were engaged at the competitive level, with the remainder at the recreational level.

2. Operative procedure[3]

One-third of the patellar tendon with bone blocks on both ends was harvested and tubed with absorbable sutures. Woven polyester was sutured tightly

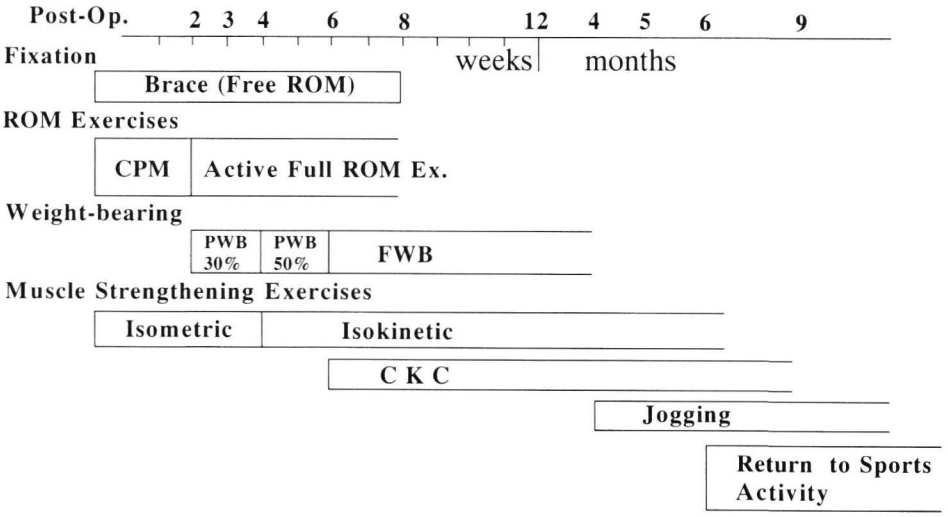

Fig. 1 Postoperative rehabilitation program

around the patellar tendon to make a composite graft with a diameter of 8 mm. The intraoperative measurement of graft isometry was performed using our custom-made isometer[4]. The graft was passed through the tibial and femoral tunnels, and was fixed to the femur by double staples, and to the tibia by a screw. After fixation of the graft, the knee was put through a full range of motion to ensure proper tightness of the graft. A notch plasty was performed if the graft impinged on the intercondylar notch.

3. Postoperative rehabilitation program[5]

A hinged brace was applied immediately after the operation. On the second postoperative day, range of motion exercises on a continuous passive motion device and isometric muscle exercises were begun. Partial weight-bearing was allowed at 2 weeks after surgery, increasing to full weight-bearing at 6 weeks. Isokinetic muscle exercises were started at 4 weeks postoperatively, and closed-kinetic-chain exercises at 6 weeks. The hinged brace was removed at 8 weeks, and re-engagement in sports activities was recommended from 6 months. The patients advanced in their sports at their own paces, and full sporting activity was allowed at 1 year after ACL reconstruction (Fig. 1).

4. Evaluation

All twenty-four patients were evaluated qualitatively using the Lysholm knee scoring system[6] and quantitatively using the KT-2000 knee arthrometer.

A modified Lysholm knee scoring system (full marks, 100 points), which had been devised originally for qualitative evaluation of the reconstructed ACL in sports activities, was available for this study (Table 1). The twenty-four studied patients were divided into two groups based on their Lysholm scores. The patients with Lysholm scores in sports activities of 90 points or more were placed in Group 1, and those with scores of less than 90 points in Group 2.

Quantitative evaluation included range of motion and the KT-2000 knee arthrometer measurements. All KT-2000 knee arthrometer measurements were made by one trained examiner (AM). We used one arthrometer for all measurements and followed the measurement procedures established by previous researchers[1, 7]. The KT-2000 knee arthrometer was designed to perform an anteroposterior drawer test by applying a manual force to the proximal tibia, and a plotted response curve of the anteroposterior force versus anteroposterior displacement of the tibia was obtained. The following two parameters were calculated from the force-displacement curve : 1) AD : anterior displacement (displacement from 134 N

Table 1 The modified Lysholm score in sports activities
(Underlined : Arranged parts in sports activities)

LIMP:	
None	5
Slight or periodical	3
Severe and constant	0
SUPPORT :	
None	5
Bracing	3
Weight-bearing impossible	0
SLOPE or STEP RUNNING :	
No problem	10
Slightly impaired	6
One step at a time	2
Unable	0
SQUATTING :	
No problem	5
Slightly impaired	4
Not past 90	2
Unable	0
ATROPHY IN THIGH :	
None	5
1 - 2 cm	3
More than 2 cm	0
RUNNING, JUMPING, AND TURNING	
A. INSTABILITY :	
Never giving way	30
Rarely during severe athletic exertion	25
Frequently during severe athletic exertion	20
Occasionally in light warming-up	10
Often in light warming-up	5
Every step	0
B. PAIN :	
None	30
Inconstant and slight during severe exertion	25
Marked on giving way	20
Marked during severe exertion	15
Occasionally in light warming-up	10
Marked on light warming-up	5
Constant and severe	0
C. SWELLING :	
None	10
On giving way	7
On severe exertion	5
On light warming-up	2
Constant	0

(total 100 points)

anterior force to 0 N force); and 2) ATS : anterior terminal stiffness (stiffness at 134 N anterior force). For the quantitative evaluation of the reconstructed ACL, ADD (the injured-to-uninjured difference of anterior displacement [injured side minus uninjured side]) and ATSR (the injured-to-uninjured ratio of anterior terminal stiffness [the percentage of injured side to uninjured side]) were analyzed.

The differences in range of motion between Group 1 and Group 2 were evaluated. Then the injured-to-uninjured differences in anterior displacement between Groups 1 and 2 were evaluated, as was the relationship between the injured-to-uninjured differences in anterior displacement and the Lysholm score in sports activities. In addition, the injured-to-uninjured ratio of anterior terminal stiffness between Group 1 and Group 2 was evaluated, as was the relationship between the injured-to-uninjured ratio of anterior terminal stiffness and the Lysholm score in sports activities. Statistical analysis was performed using Fisher's exact probability test, Student's t-test, and Pearson's correlation coefficient ; a value of less than $p = 0.05$ was considered statistically significant.

Results

The average Lysholm score on sports activities for the twenty-four patients was 90.5 ± 6.1 points (with score ranging from 77 to 100). Fourteen of them had Lysholm scores in sports activities of 90 points or more, and comprized Group 1. The other ten patients had Lysholm scores of less than 90 points, and comprized Group 2.

Four patients had mild limitation in their range of motion of 10° or less (one in Group 1, three in Group 2). There was no significant difference between the two groups.

The average injured-to-uninjured difference in anterior displacement for the twenty-four patients was 1.6 ± 3.6 mm (with difference ranging from -3.9 to 9.1 mm). The injured-to-uninjured difference in anterior displacement in Group 1 (0.7 ± 2.7 mm) was smaller than that in Group 2 (2.9 ± 4.4 mm), but there was no statistically significant difference between the two groups (Table 2). Furthermore, there was no statistically significant correlation between the injured-to-uninjured difference in anterior dis-

Table 2 Injured-to-uninjured differences in anterior displacement using the KT-2000 arthrometer at 134 N anterior force

Lysholm Score	Injured-to-Uninjured Difference in Anterior Displacement[a]
Group 1 ≧ 90 points (n=14)	0.7 ± 2.7 mm
Group 2 < 90 points (n=10)	2.9 ± 4.4 mm

[a] There was no statistical difference between the two groups.

Table 3 Injured-to-uninjured raito of anterior terminal stiffness using the KT-2000 arthrometer at 134 N anterior force

Lysholm Score	Injured-to-Uninjured Ratio of Anterior Terminal Stiffness[a]
Group 1 ≧ 90 points (n=14)	107.6 ± 41.6 %
Group 2 < 90 points (n=10)	66.3 ± 24.3 %

[a] There was a significant difference between the two groups ($p<0.01$).

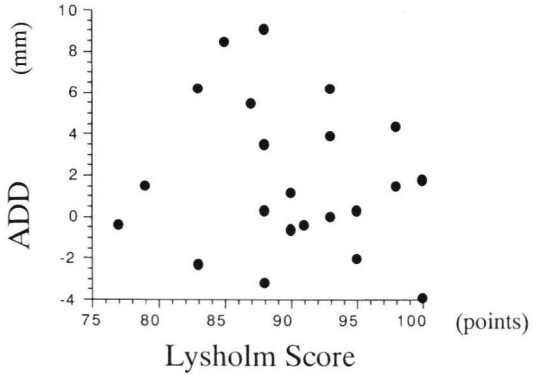

Fig. 2 Relationship between the injured-to-uninjured difference in anterior displacement (ADD) and the Lysholm score in sports activities.
There was no statistically significant linear correlation.

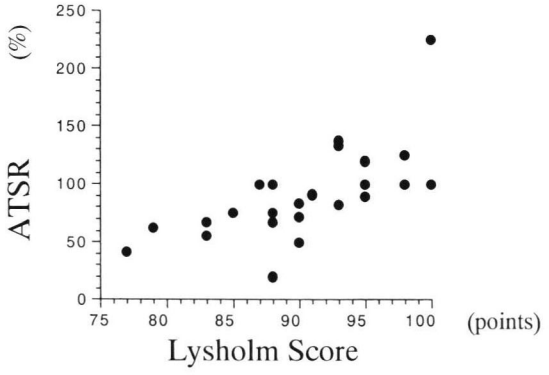

Fig. 3 Relationship between the injured-to-uninjured ratio of anterior terminal stiffness (ATSR) and the Lysholm score in sports activities.
There was a significant correlation ($r=0.669$, $p=0.0002$).

placement and the Lysholm score in sports activities (Fig. 2).

The average injured-to-uninjured ratio of anterior terminal stiffness for the twenty-four patients was 92.0 ± 40.1 % (range, 20.0 to 225.0). The injured-to-uninjured ratio of anterior terminal stiffness in Group 1 (107.6 ± 41.6 %) was statistically higher than that in Group 2 (66.3 ± 24.3 %) ($p<0.01$) (Table 3). There was a significant correlation between the injured-to-uninjured ratio of anterior terminal stiffness and the Lysholm score in sports activities ($r=0.669$, $p=0.0002$) (Fig. 3).

In this study, there was no statistically significant difference between the two groups in age at surgery, interval from injury to surgery, associated meniscal tear, and level of sports activities. Furthermore, there was no statistically significant correlation between the age at surgery and the Lysholm score in sports activities, nor between the interval from injury to surgery and the Lysholm score in sports activities.

Discussion

There are many factors influencing the quality of postoperative sports activities after ACL reconstruction, for example, joint laxity, joint stiffness, muscle strength, coordination, and agility. Of these factors, quantitative instrumented measurement of anterior knee laxity is generally accepted as the optimal parameter for evaluating results[8, 9]. In this study, AD (anterior displacement, i.e. anterior knee laxity) was calculated using a KT-2000 knee arthrometer, and ADD (the injured-to-uninjured difference in anterior displacement) was analyzed. However, some pati-

ents with good anterior knee stability after ACL reconstruction were not entirely satisfied with their performance in running, jumping, and turning, which are essential skills in a variety of sports activities. Markolf et al.[10] and Daniel et al. [11] have emphasized that quantitative instrumented measurement of the stiffness at the end-point is another important parameter for assessment of ACL integrity, and it is postulated that the stiffness at the end-point is one of the factors determining the degree of skill in running, jumping, and turning. In this study, ATS (anterior terminal stiffness, i.e. the stiffness at the end-point) was calculated using a KT-2000 knee arthrometer, and the ATSR (the injured-to-uninjured ratio of anterior terminal stiffness) was analyzed.

The KT-2000 knee arthrometer is a very useful tool in clinical practice because of its simplicity, portability, and wide availability. Wroble et al.[12] have indicated that error in instrumented ligament testing arises from one or more of several sources ; the device, the examiner, and the patient. Despite this suggestion, previous literature has provided support for both the reliability and validity of the KT-2000 knee arthrometer. Steiner et al.[13] and Myrer et al.[14] have reported its reliability and validity for measurements of anterior displacement ; and Bach et al.[15] and Highgenboten et al.[16] have reported its reliability and validity for measurements of anterior terminal stiffness.

In the present study, all twenty-four patients were evaluated at eighteen months or more after ACL reconstruction, because we considered patients to be most athletically active when the postoperative rehabilitation process was completely over. Also, our previous follow-up study after ACL reconstruction using a patellar tendon augmented with woven polyester demonstrated that anterior displacement did not increase with time from eighteen to sixty months postoperatively[3].

Harter et al.[17], and Marder et al.[18], reported that the average injured-to-uninjured difference in anterior displacement at 89 N force was 2.2 mm, and 1.6 mm, respectively, in a two-year follow-up of ACL reconstruction with the autogenous patellar tendon. In the present study, the average injured-to-uninjured difference in anterior displacement was 1.6 mm at 134 N force, which appeared to be consistent with that found in previous studies.

As for the relationship between the anterior displacement and the quality of postoperative sports activities after ACL reconstruction, Johnson et al.[19] reported the presence of less anterior displacement in a knee rated good or excellent in subjective functional results compared with a knee rated fair or poor, whereas Kramer et al.[20] reported that anterior displacement was poorly correlated with activity level. In the results of this study, the injured-to-uninjured difference in anterior displacement in Group 1 was smaller than that in Group 2, but we found no statistically significant difference between the two groups. Moreover, we found no statistically significant correlation between the injured-to-uninjured difference in anterior displacement and the Lysholm score in sports activities. On the other hand, to our knowledge, no detailed studies have been done on the correlation between the anterior terminal stiffness and the quality of postoperative sports activities after ACL reconstruction. In the results from this study, the injured-to-uninjured ratio of the anterior terminal stiffness in Group 1 was statistically higher than that in Group 2. Furthermore, we found a significant correlation between the injured-to-uninjured ratio of the anterior terminal stiffness and the Lysholm score in sports activities.

These results suggested that the anterior terminal stiffness was an important factor influencing the quality of postoperative sports activities, especially running, jumping, and turning skills, and that anterior terminal stiffness was more useful as a parameter for evaluating the function of the reconstructed ACL in postoperative sports activities than anterior displacement. Therefore, the anterior terminal stiffness in athletes who are able to continue their sports activities satisfactorily for a long period after ACL

reconstruction can be considered to have increased sufficiently, and their reconstructed ACL should be interpreted to have acquired a good functional basis.

Conclusion

Two parameters (the anterior displacement and the anterior terminal stiffness) were measured using a KT-2000 knee arthrometer in patients who had continued sports activities after ACL reconstruction. Although the injured-to-uninjured difference in anterior displacement was poorly correlated to the Lysholm score in sports activities, the injured-to-uninjured ratio of the anterior terminal stiffness was found to be significantly related to this score. The anterior terminal stiffness was concluded to be more useful than the anterior displacement as a parameter for quantitative functional evaluation of the reconstructed ACL in postoperative sports activities.

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Neuromuscular Coordination and Anterior Cruciate Ligament Injuries－A Gait and Running Analysis with EMG on a Treadmill

Eckhardt Rainer
Puhl Wolfhart
Scharf Hanns-Peter

● Key words
ACL-ruptures : Neuromuscular-coordination : Gait-analysis

● Abstract

Injuries of the cruciate ligaments have a high relevance in sports medicine and public health. The questions about operative versus conservative therapy and the ability to exercise after injuries of the cruciate ligament are still in discussion. Even though the existence of a neurosensory function in addition to the mechanical function of the anterior cruciate ligament has been known for years, this knowledge has not yet been applied in sports medicine examinations.

The aim of this study was to prove whether operative treatment of anterior cruciate ligament rupture restores its neuro-sensory function and therefore lead to a normal load during exercise. In this prospective controlled study, 20 healthy athletes and 20 persons with knee instability underwent a functional EMG examination with different loads.

As most important results of this examination we consider :

1. By utilizing electromyography we were able to develop reproducible and valid measurement parameters. We were able to steer the stress and strain of the knee joint and it's stabilizing muscles under different kind of load.
2. Comparing the different groups, the stabilizing muscles show statistically differences in neuromuscular coordination.
3. After insufficient reconstruction of the anterior cruciate ligament as a diminished innervation of the biceps femoris muscle and the gastrocnemius muscle while walking downhill.
4. In spite of subjective stability we found an enhanced strain and stress on the knee joint, caused by loss of neuro-sensorial function of the cruciate ligament. The load of the knee joint after cruciate ligament injuries depends considerably on the individual ability of neuromuscular coordination.
5. In conclusion from our findings, we suggest that clinical methods should be developed to allow a patient-specific assessment of physical activity.

Rainer Eckhardt, MD
c/o Orthopaedic Clinic University Ulm
Orthopaedic Clinic RKU
Oberer Eselsberg 45
D-89081 ULM/Donau
TEL + 49 731 177 1130/FAX + 49 731 177 1134

Orthopaedic Department Universität Ulm

Introduction

The relevance of injuries of the anterior cruciate ligaments results from their frequency[48] and the functional significance of the cruciate ligament for stability and efficiency of the knee joint[5, 22 ~ 25]. However, the consequences of the cruciate ligament injuries for the functional efficiency during exercise remain unclear[21]. Allman[2] has described the increasing instability of the knee joint caused by loss of the anterior cruciate ligament as well as the failure of secondary stabilizers leading to instability with subsequent arthritis.

The clinical observations show different results[1, 3, 7, 11, 17, 32, 34, 37]. Good results following conservative treatment are reported for isolated cruciate ligament ruptures[6, 19, 49, 51]. These findings result from the high level of subjective efficiency of the knee joint when the time period between reexamination is short. However, the subjective rating depends not only on the mechanical function of the ligament, but also on a sufficient muscular stabilization which is ensured through the arthrocinetic reflex arc[20, 31, 52].

The sensors of this reflex arc are mechano-receptors which are found in the pericapsular tissue[4, 13 ~ 15, 18, 28, 29, 36, 39, 40, 45]. Therefore, the neurosensorial function of the cruciate ligament is proven on a morphological level[12, 15, 35, 41, 53]. It's significance on the functional level, is reported in the literature.

Shiavi et al.[43] noticed "moderate through great changes in the activity of the majority of muscles". Tibone et al.[50] found differences in the EMG activity in free gait on a plane which were enhanced with increasing speed. Solomonow et al.[46, 47] reported that direct high (1-2 kg) stress on the anterior cruciate ligament resulted in a weak inhibitory effect on the quadriceps femoris muscle, and also led to direct stimulation of the hamstrings. A similar pattern of reflex response was seen in patients with damage to the anterior cruciate ligament. Branch et al.[8] showed a 38 % higher integral and 32 % higher EMG voltage of the hamstrings after cruciate ligament rupture in the side step test. In a controlled EMG study, Lass et al.[30] examined patients without anterior cruciate ligament at 0 % and 25 % slope. They found an earlier onset in the hamstring muscles and the gastrocnemius muscle. The duration of the EMG activities was likewise extended. In their study, Kaalund et al.[26] compared two groups of seven patients, each of which had isolated anterior cruciate ligament rupture and excellent versus poor postoperative results on the treadmill. They found significant differences only in the gastrocnemius with an earlier onset and an extended duration of muscle activity. Shiavi et al.[44] showed in their study with 26 healthy individuals and 20 patients with cruciate ligament ruptures why cruciate ligament injuries change the activity of single muscles or groups of muscles. A newly developed cluster technique for EMG analysis was used for evaluation. The results showed that there are typical or "normal" patterns of muscular activity in healthy and cruciate deficient patients. The few atypical patterns indicating cruciate ligament insufficiency were especially seen in fast running.

These results are not proof for the functional importance of neurosensorial properties of the cruciate ligament, but they provide some indications.

In the present study the following questions will be addressed :

- How is the innervation of the knee stabilizing muscles influenced during different loads ?
- Are there differences in the innervation of the knee stabilizing muscles after anterior cruciate ligament reconstruction ?
- What is the significance of changes in the neuromuscular coordination after ACL-reconstruction for the functional load of the knee joint.

Material and methods

The study was performed on two groups. Group 1 consisted of 20 healthy athletes (control group); Group 2 consisted of 20 patients after ACL-recon-

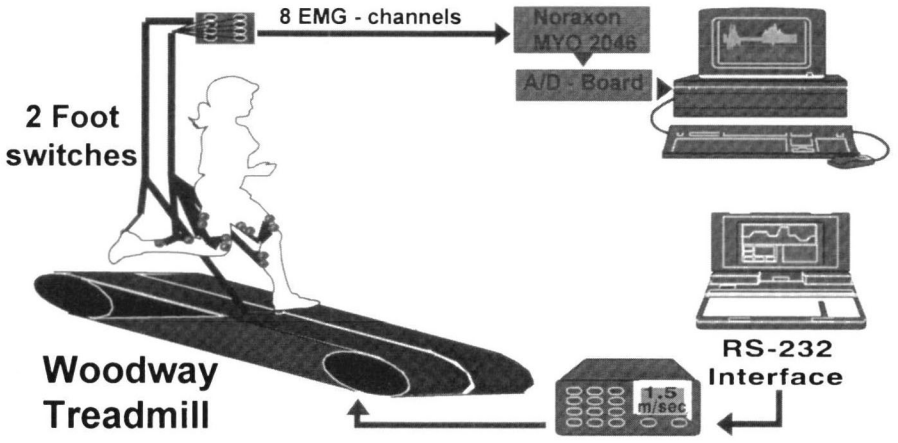

Fig. 1 Treadmill and Electromyographie

struction (ACL-group). The participation of all individuals was voluntarily.

The control group consisted of 20 healthy athletic individuals in an age range between 10 and 30 years. The mean age was 20.8 years, the mean body weight 68.4 kg and the average height 173.3 cm.

The ACL-group consistent of 20 patients of both genders. In 13 patients the anterior cruciate ligament was replaced by an autologous transplant. At the time of removal of the metal cramp, an arthroscopy was performed and a unilateral isolated anterior cruciate ligament insufficiency was diagnosed. In 7 of the patients at the time of the trauma only an arthroscopy, but no cruciate ligament reconstruction had been performed. With the exception of 4 patients, all patients with ACL insufficiency were exercising. The average activity per week (2-8 hours) is consistent with the average activity level of people exercising through leisure sports.

1. Methodology of measurement and data evaluation

The neuromuscular coordination of the knee joints was examined on a treadmill (Firma WOODWAY, Weil am Rhein, Germany) with a eight canal EMG (Firma NORAXON OY, Oulu, Finnland) and two foot-switches (Firma PENNY & GILES, Augsburg, Germany) (Fig. 1). The skin of the lower extremities was degreased and the surface EMG electrodes where administered at the typical location above the respective muscles. The foot-switches were fixed with tapes 3 at the foot, and the calibration was performed while putting weight only on one leg. All patients were informed of the brake times and loading times before starting the belt.

The treadmill was controlled via a computer. Therefore, the infinitely variable increase of speed between 0 and 30 km/h as well as a changes in the slope from −30 to +30 % were possible. The subjects were allowed to adjust to the situation on the treadmill at 0 % slope and a speed of 1.5 m/s for 2 minutes. In the third minute, at a speed of 3.0 m/s, the EMG was begun. After that, the speed was reduced slowly to 0 m/s and in the following break (60 sec.) a slope of 20 % was adjusted (Fig. 2). At the speed of 3.0 m/s the subjects ran uphill for 1 minute, followed by a 1 minute break during which the subjects turned their direction 180° and ran 3.0 m/s downhill. At each speed 100 double steps were registered.

2. Electromyography

The registration of muscle activity potentials was performed with an 8-canal-EMG device. The signals were obtained utilizing AG/AGCL children's ECG electrodes (Firma 3M, Neuss, Germany) (diameter 2cm, distance 2cm). After pre-enhancement the analogous signals were digitalized in an A/D

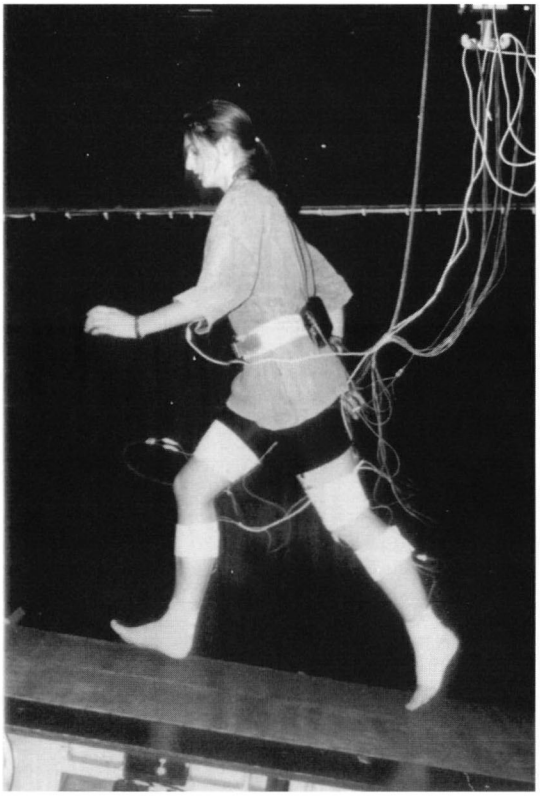

Fig. 2 Photo with uphill runner

board and transferred to a PC with the necessary software. Utilizing a RAM extension it was possible to register 8 EMG canals and two analog signals (foot-switches) at a frequency of 500 Hz for 1 minute at a time. The ON/OFF signal of the foot-switches was recognized by the software and served as a reference point for the calculation of the EMG-parameters.

The EMG activity of the biceps femoris muscle and the gastrocnemius muscle were registered bilaterally, the electrodes were fixed at the typical locations (Fig. 3). In order to test whether the measurement device was working properly, each muscle was contracted individually and the EMG signal was optimized.

3. Measurement parameters

The following parameters were calculated from the EMG potentials and the foot-switches.

4. Onset

Onset is the period of time between the beginning of the muscle activity potential and the heel contact (Fig. 4). If the muscle activity starts before the heel contact the onset is negative, after the heel contact it is positive. The beginning of the action potential was defined by the following mathematical operation : During three consecutive muscle actions, the mean

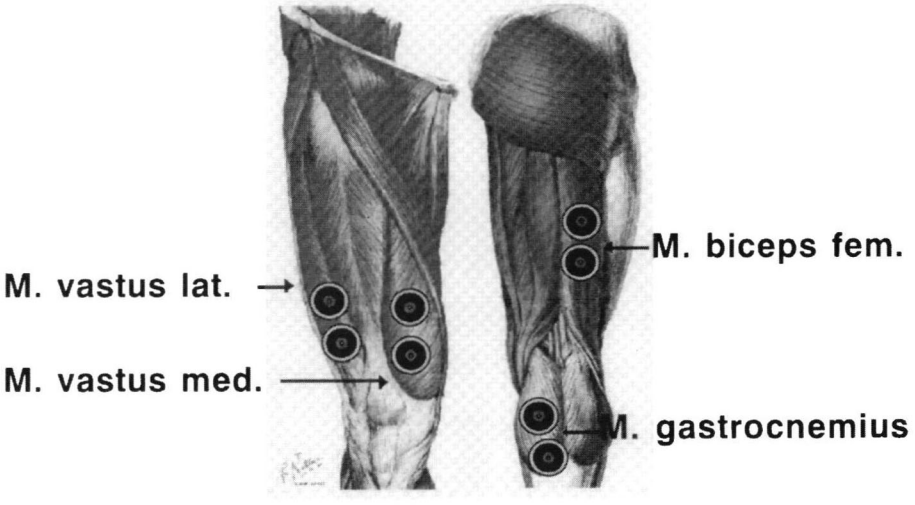

Fig. 3 Positioning of the EMG-electrodes

value and the standard deviation of the ground-noise were calculated. As soon as the measured voltage of the action potential differed from the triple standard deviation of the unloaded potential, it was considered the beginning of the action potential. It was thus possible to define the beginning of a muscle action at a degree of probability of 97.5 %.

5. Integral

By integration of the potential graph, the area below the graph was determined (Fig. 4). These values were analogous to the force of the respective muscles. However, they did not correspond with physical muscular power.

6. Methods of statistic data evaluation

On the basis of the present data, material, and the available random samples the arithmetic mean was determined in order to describe the tendency of the parameters. The description of the width of the distribution was measured with the standard deviation. Possible relations and differences were tested with the T-Test. All statistical evaluations were performed with SPSS-Software.

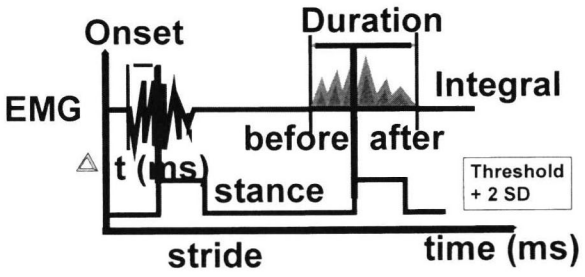

Fig. 4 Calculation of ONSET, Duration and INTEGRAL

Results

1. Clinical results

Height and weight did not differ in variance analysis in either group. The mean age of the ACL-group, however, was significantly higher than that of the athletes ($p < 0.01$). The examination of stability with KT-1000 resulted in a significant difference between each group according to the definition, the intraindividual right/left side difference in the ACL-group was 3.5 ± 2.4 mm and in the athlete group 1.3 mm ± 1.2 mm ($p < 0.01$). The mean Lysholm score in the ACL-group was 79.7 points and differed significantly from the 99.7 points of the athletes. The Tegner score of the athletes showed an activity

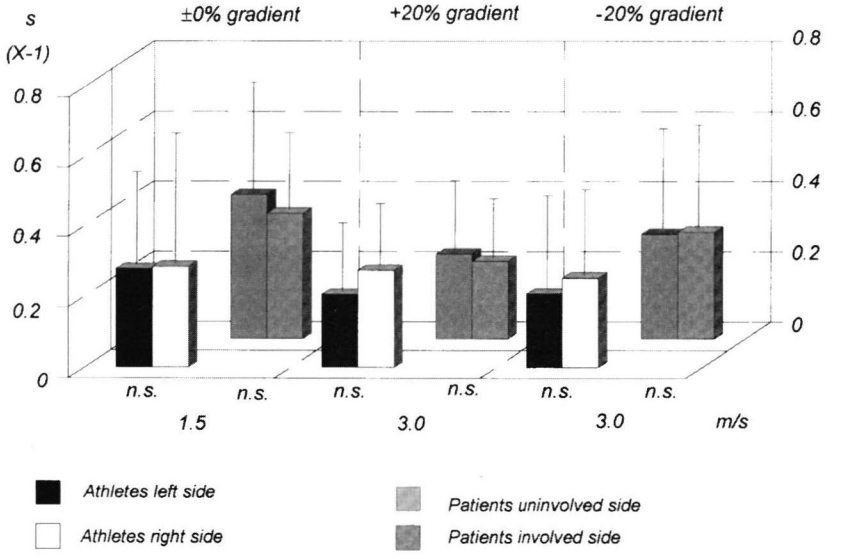

Fig. 5 Onset of m. biceps femoris

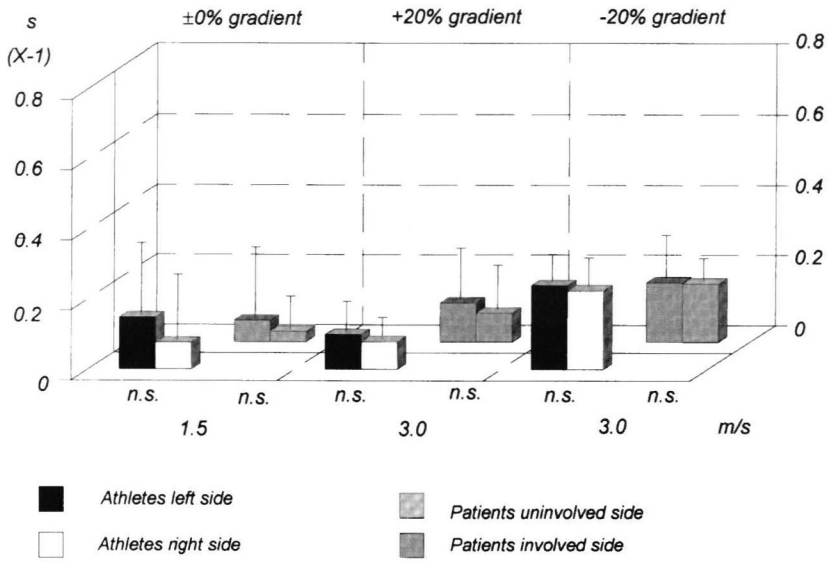

Fig. 6 Onset of m. gastrocnemius

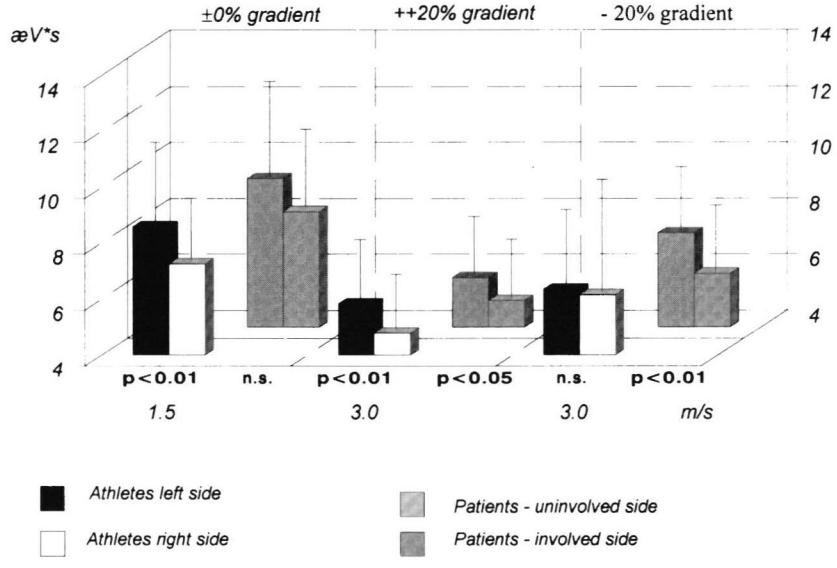

Fig. 7 Integral of the m. biceps femoris

degree of 8.5 ± 0.7 points and in the patient group 5.7 ± 1.5 points. Therefore it was also significantly different.

2. Electromyographic results

The neuromuscular coordination of the knee joint was described with the two electromyographic parameters onset and integral of the EMG curve for the biceps femoris muscle and the gastrocnemius muscle.

The onset of the biceps femoris muscle was shorter in the athlete group than in the ACL-group. The difference, however, was not statistically evident. An intraindividual side difference at the time of the muscle activation while walking or running in different speeds and slopes was also statistically insignificant (Fig. 5).

The onset of the gastrocnemius muscle showed no difference at the intraindividual side difference of either group or inter-individually between control

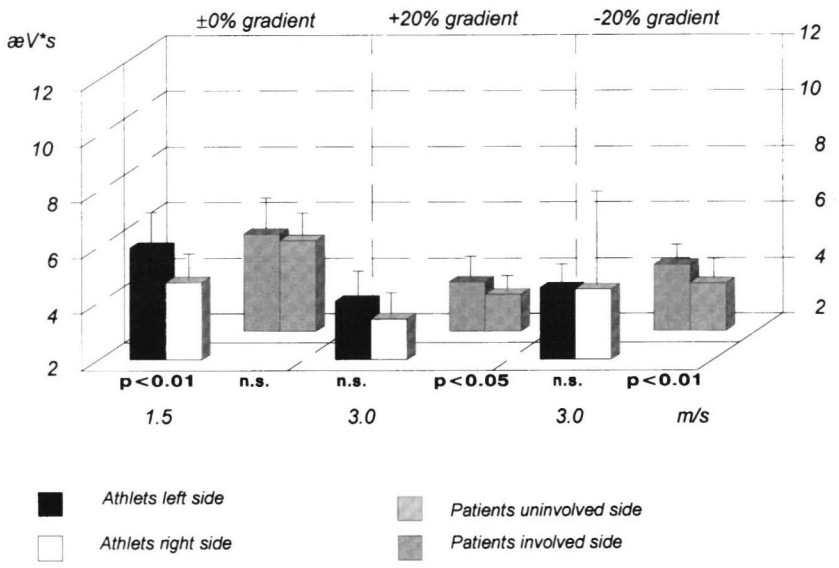

Fig. 8 Integral of the m. gastrocnemius

and ACL-group. However, in the tendency the onset in the control group was longer (Fig. 6).

The integral of the EMG in the control group (91.5 % right-handed) at the biceps femoris muscle showed significant ($p < 0.01$) lower values in the right extremity while walking in the plane and running uphill. At running downhill, these side differences were lost (Fig. 7).

Patients with knee instability showed a reverse reaction. While walking at 1.0 m/s on the plane they did not show any statistically proven difference in the right/left side comparison. However, the area below the EMG-curve was slightly significant ($p < 0.05$) while running upstairs, and was highly significant ($p < 0.01$) while running downhill. The area below the graph was smaller on the unstable side (Fig. 7).

More significant than at the biceps femoris muscle was the different reaction of the integral between the two groups at the gastrocnemius muscle. In the control group the muscle activity level (integral) was significantly different only while walking in the plane favoring the right side, however, while running uphill or downhill there was no statistically significant difference (Fig. 8).

Patients with ACL deficiency, however, showed no significant difference between sides while walking in the plane as was the case in the biceps femoris muscle. In the control group, the integral was significant ($p < 0.05$) at a speed of 3.0 m/s and 20 % slope and highly significant at − 20 % slope, disfavoring the unstable side (Fig. 8).

Discussion

The anterior cruciate ligament has different functions. The biomechanical function as ligamentous stabilizer of the knee joint is well known. According to cinematic studies, the cruciate ligaments are the inner gear unit of the knee joint[35].

Several clinical observations have led to the assumption that the cruciate ligaments also have neuro sensorial functions. The possible functional reconvalescence after ligamentous knee injuries with or without operations on one side and the degenerative changes in the joint in spite of optimal surgical treatment could be explained on the basis of a primary sensorial function of the cruciate ligament[9]. This theory is supported by the proof of mechano receptors[15, 16, 27, 42] in the ligaments of the knee.

On the base of this basic knowledge different clinical and experimental studies were undertaken to analyze the value of the neuro-sensorial function of the

cruciate ligaments. These studies differed in the applied load of the knee joint, the examined muscles and the reported electromyographic results. The results ranged from "moderate to great changes of the activity in the majority of muscles"[43], to changes of the so-called onset[50], up to different activity pattern, compared by using cluster analysis[44]. However, there were no statements about changes in the stress of the knee joint and clinical consequences. The aim of our evaluation was to answer the following questions:

- Which differences in innervation can be found at different loads ?
- Do the knee stabilizing muscles show differences in their neuromuscular coordination during exercise ?
- Are these differences modified through stabilizing operations ?
- Is it possible to determine consequences in the treatment of patient with knee instabilities from the results of this study ?

The individual variability of the surface EMG is a critical factor for collective assessment of the neuromuscular coordination. In order to enhance the validity of the EMG measurements, the conditions for the analyses were standardized and a high number of steps were analyzed. The standardized load was done on a treadmill. In addition to walking in the plane, running uphill and downhill were chosen. Hereby the given speed of the treadmill was supporting an evenly rhythmic gait, which in turn led to expect regular innervation times of the muscles. Artifacts caused by irregular motion were minimized.

In order to describe the neuromuscular coordination the two parameters, onset and integral, were chosen. Onset is defined as the time between the beginning of innervation and heel strike and provides information about the reaction time of the musculature. The area below the action potential is equivalent to the product of voltage and time. This integral of the EMG correlates with the mechanical muscle strength. Both parameters are therefore suitable to describe the time and dimension of the neuromuscular power.

Among the different muscle groups of the lower extremities, the biceps femoris muscle and the gastrocnemius muscle have a special significance because they act agonistic to the cruciate ligament and therefore unburden the anterior cruciate ligament. The different load patterns (plane, uphill, downhill) lead to a different load of the anterior cruciate ligament. An estimation of the effect of mechanical forces is possible according to the literature[10, 33]. Thereby, walking downhill leads to a push of the body, resulting in a maximal stress of the ACL[10, 33].

The two collectives examined differed in their preconditions. In the ACL-group a lack of the ACL can be assumed leading to a loss of its neurosensorial functions. Morphological studies on transplants where able to prove the existence of free nerve endings, however, the proof of mechanic receptors in transplants has not been successfully demonstrated[17]. The loss of function of these transplants has been proven by control arthroscopies. In accordance to these criteria, the subjective opinion of knee stability was worse in the ACL-group than in the control group. According to the Lysholm score the level of results was sufficient to allow physical exercise activity. Analogous to the subjective judgment, the mechanical control with the KT-1000 showed an enhanced shifting of femur and tibia. Therefore, the ACL-group met the requirements to indicate disorders of neuromuscular coordination, caused by loss of sensorial function of the ACL.

The results showed no differences in the onset of both muscle groups examined. In the chosen stress pattern, the time period between beginning of muscle innervation and heel strike was equal in both groups. In this study, however, patients with a significant lower Lysholm score (55-68 points) were examined. On the other hand, the total time was limited to 3 minutes walking in the plane. In longer time periods (100 steps were analyzed per load pattern) a better adaptation to the stress was observed. This

resulted in a normalization of the onset. This effect of adaptation is also seen in the control group. The different load patterns do not lead to a changing of the onset. Obviously the timely adaptation of the onset is unproblematic due to the uniformity of the motion and is only influenced by the cadence.

The integral of the biceps femoris muscle shows significantly higher values for the left leg in the control group. This can be explained by the high share of right handers with emphasis on the contralateral lower extremity. If the stress situation is enhanced by acceleration and walking downhill, so that a maximal strenuous effort in the standphase is required, the side difference is lost. In accordance with the dominant mechanical demand, the innervation of stabilizing and antagonistic muscles are equal.

This innervation differs remarkably in the patient group. Even though we did not observe an intra individual side difference while walking in the plane between normal and involved leg, the innervation for the instable knee joint while walking downhill was reduced. In walking downhill the instable knee joint is maximally stressed and has a lower sensorial ability which leads to a less active muscular adaptation of the ACL agonist. The arthrocinetic reflex is missing and leads to a reduced innervation of the hamstrings.

In the interpretation of the integral, an analogous proportional relation to the muscular force is assumed. Therefore, a predisposition is the correct standardized measuring technique. However, a interindividual comparison of absolute values is problematic because several individual factors such as skin resistance, thickness of subcutaneous fat or number of motor endplates influence the values. These factors can be ignored if an intraindividual comparison is possible. The intraindividual comparing measurements therefore allow a conclusion of the mechanical stress of the knee joint in the ACL-group. Mechanically the gastrocnemius muscle works agonistic to the biceps femoris. It is therefore understandable that it shows the same stress-dependent side differences.

The muscles working agonistic to the anterior cruciate ligament are adapting to the different stress on the ligament. This is caused by an enhanced innervation which leads to a greater integral. In contrast, the beginning of innervation is not used as a regulator but remains constant. If the arthrocinetic reflex arc is interrupted due to loss of the anterior cruciate ligament, the adaptation to stress is limited since the adaptation of the muscle innervation is disturbed and the muscle force reduced. Therefore, it is insignificant whether the interruption is caused by insufficiency of the anterior cruciate ligament or lack of re-innervation of a transplant.

The neurological deficit results in a higher functional stress of the joint surfaces. This is independent from clinical examinations whether the patient have postoperative a stable knee joint or a lack of subjective complaints. This excess in stress can lead to damage of the joint surfaces resulting in instability and/or arthritis. This explains the medium term unfavourable clinical results.

A consequence of anterior cruciate ligament reconstruction is that it leads to a different physical load on the knee joint. The borders between tolerable and vulnerable stress are defined through individual predisposition and the amount of physical activity[38]. They cannot exactly be defined by clinical examination criteria. It is possible that a full restoration of an injured cruciate ligament can neither biologically nor functionally be achieved. Any statement as to whether the person is able to exercise after anterior cruciate ligament surgery mainly depends on neuromuscular compensation which is still beyond our standard examination techniques. However, if one ignores the neurosensorial function of the anterior cruciate ligament, the midterm results of ACL reconstruction will continue to be disappointing.

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Injuries by Mountainbikes The Long Way Back to the Track —About the Injury Pattern of High-class Mountainbikers—

Markus P. Arnold
Niklaus F. Friederich
Roland Biedert

● Key words
Bike : Mountainbike : Injury : Sports-traumatology

● Abstract
The typical injury-pattern of high-class mountainbikers is presented and analysed. Between 1993 and 1997 the injuries of the Swiss National Mountainbike-team were prospectively recorded. The team averaging 45 members per season was followed be one doctor. Eighty-nine major injuries occurred during this period, 36 were treated by an operation, 53 non-operatively. The most common injuries were : Commotio cerebri(16), shoulder and wrist injuries(30), knee injuries(12). About every third team-member had to deal with one major injury per season. This corresponds to a risk of injury of 39.5 % per biker per 1,000 hours of sports-activity. Therefore we feel that mountainbiking on an international level is not harmless. High-class athletes equipped with top-material get injured too often and too severely. Because of the recent developmental progress in bike-technology, an increasing number of severe injuries has to be expected.

Dr. med. Markus P. Arnold
Arts-assistent
Academisch ziekenhuis
Sint Radboud
Afdeling Orthopedie
Th. Craanenlaan 7
NL-6500 HB Nijmegen
TEL ++31 24 361 41 48/FAX ++31 24 354 02 30

Klinik für Orthopädie und Traumatologie
des Bewegungsapparates

Introduction

Mountainbiking is fun, mountainbiking is trendy. But mountainbiking may also be dangerous.

The bike-industry has been working very innovatively over the past five years.

Modern suspension-systems, including bikes with suspensions at front- and rear-wheel, new, unexpectedly powerful break-systems have been introduced, allowing the riders to drive quite safely on extremely high speed levels. Those bikes are available for everyone, the prototypes ridden by the professional riders are equipped with even further advanced features. Top-speed measurements on the occasion of international downhill race events showed figures beyond 100 km/h.

Mountainbiking has to be divided in two completely different categories : Crosscountry (CC) and downhill (DH). In Atlanta 1996 CC-mountainbiking was introduced as an Olympic discipline. CC-races usually lead over a distance of about 3 hours, the track running most of its length through forest and over meadows. The discipline may be looked at as physically and technically quite demanding for the riders.

DH-mountainbiking is best comparable to downhill-skiing : the competitor's goal is to get in as short time as possible from the top of a hill down to the valley. Top-speeds of about 100 km/h are recorded regularly. Usually the track is laid out treacherously, the borders consisting of trees or gorges, the surface of stones, gravel and roots. Racetimes normally are measured between 3 and 5 minutes, it is wrong to believe, this sport was not demanding. The motto of the riders : no fear !

Prevention

CC-riders try to protect themselves with usually available helmets, handkerchiefs without any finger-protection and goggles. Concerning the safety-measures along the track, only the very most dangerous parts in descents are roughly secured by straw mats.

DH-riders do not care that much of the weight of their equipment. Therefore by most of the riders more is done for the passive security. Most of them wear protectors of shoulders, spine and knees, a helmet with a safety-device for the face is usually worn. In relation to the speeds attained, track-safeguards are almost absent.

Both categories do not dispose of a drivers organisation, there is no security-lobby for drivers existing. The international bikers federation UCI does check the tracks before an event, the main aim not being drivers security but the most spectacle possible for public and media.

Material and methods

Between 1993 and 1997 the first author followed and treated the Swiss Mountainbike Nationalteam. During those 5 seasons all important injuries occurring were recorded. The team during those years was composed of about 45 members, 40 % of them female and 60 % male riders. All teammembers were regularly examined each spring during a pre-season-check-up. Injuries happenign during the season were reported to the team-doctor to co-ordinate further treatment with the team-coach.

Banal injuries such as contusions or skin-lesions were not registered, they are just part of the game.

Results

During 5 seasons of competitive mountainbiking a total of 89 major injuries were recorded among the members of the Swiss Mountainbike Nationalteam. Thirty-six lesions were treated operatively, 53 were treated non-operatively. The lesions in detail are shown in Table 1. The upper half of the body consisting of head, cervical spine, shoulder-girdle and arms was injured 64 times (71.9 %). The lower parts with abdomen, pelvis, hip and legs were injured 25 times (28.1 %) (Table 2).

Table 1 Injury-distribution

Therapy		operatively	non-operatively
• Commotio cerebri (1 night in hospital)			16
• Tooth-fractures		2	
• cervical-spine distorsions (>1y)			3
• nose-fracture			2
• shoulder-dislocations anterior		2	
• .	post		1
• fractures of the clavicle		6	8
• AC-dislocation	Tossy II		4
• .	Tossy III		2
• elbow	supracond. fx	1	
• .	olecranon-fx	2	
• forearm-shaft-fx		2	
• radius-fx	smith	1	1
• .	colles	1	4
• scaphoid-fx		2	1
• scapho-lunate dissociation			2
• Rolando-fx		1	
• major abdominal trauma		2	
• intertrochanteric fracture of femur		1	
• shaft-fx of femur		1	
• knee	lca	2	
• .	lcp		1
• .	complex	1	
• .	patella-fx	1	3
• .	meniscal leasion	2	
• .	plica mediopatellaris	2	
• upper ankle joint distorion	lat.	1	5
• .	med.	1	1
• fx of talus		1	

The risk for each member of the Swiss National Mountainbiketeam to get a major injury per season, was an appalling 25.3 %. Calculating the risk per 1,000 hours of "exposition", 39.5 % are the result, basing on a common volume of 15 hours of training and competition per week.

The common cause of accident was almost everytime identical : The drivers use to crash during a descent.

No significant difference in the chance of injury was found between CC and DH. Even the severity of injury was not found to differ significantly. As a tendency, in DH the injuries are more harmful than in CC, the further developed devices for passive security avoid most of the more banal injuries.

Discussion

Competitive mountainbiking on an international level is not harmless. We could find no data in the available literature about a prospective study in a well-defined group of persons, most articles are dealing with one specific race-event[1~5].

The two different categories, CC and DH, are attracting two different types of riders. The CC-riders can rather be compared to street-race bikers, even the injury pattern is comparable[6], although it must be mentioned that the mountainbiker runs addi-

Table 2 Injury-distribution, summary of most important locations

Commotio cerebri	17	%
Clavixulafractures, Acromioclavicular-joint lesions	23	%
Elbow, forearm- and wrist-lesions	20	%
Kneeinjuries	14	%

tional risks of injuries, as reported in this article. DH-riders can be best compared with freestyle snowboarders, freaky and following a special life-style. Astonishingly enough we found that both groups show roughly the same injury-pattern.

All mountainbikers are wearing a helmet, as soon as they get close to their bikes. Nevertheless 16 times a commotio cerebri had to be counted. What does this mean : We think, that still the helmets are not safe enough, they do not prevent serious brain-damages in mountainbiking. The helmets used by DH-riders are only preventing from skin lesions[7], fractures of nose and teeth can still not be excluded.

Similar to a study from New Zealand[8] we found a high incidence of forearm and wrist-injuries.

Even a hip-fracture occurred, in our collective it had nothing to do with the use of clipless pedals[9].

It can be assumed, that members of the Swiss Mountainbike Nationalteam are drivers with a certain level of drivers skills, ranking 3rd nation at the last 3 world championships. We are afraid of the fact, that anyway 1 of 4 riders runs the risk of 1 serious injury per season !

What about the future ? We expect that it will even get worse. The bikes are getting closer and closer to motorbikes, technically spoken. The speeds achieved in high-speed passages that are controllable will get even higher than today. But nobody is improving the safety-devices, neither on drivers nor on the tracks. We are really scared of these facts and believe, that, without a major change in the philosophy of this sport, deadly wounded riders will be the result.

What said the German DH-star Jürgen Benneke ? "Who touches the breaks has lost the race."

One possibility could be to further promote the dual-slaloms for DH-riders. This is a new discipline getting more and more popular among riders and fans. The top-speeds are kept in a reasonable and controllable range, show, thrill and fun are present, so we believe this to be the solution for the otherwise doomed sport of downhill-racing.

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Three-Dimensional Computerized Tomographic Imaging for Sports Injury in the Elbow Joint

スポーツによる肘関節障害に対する三次元CTの有用性

Makoto Hirakawa 平川 誠 Kenichi Tabuchi 田渕 健一
Takahiko Iwano 岩野 孝彦 Hideo Shibuta 渋田 秀樹
Kota Miyoshi 三好 光太

● Key words
Sports injury in the elbow joint : Three-dimensional computerized tomographic imaging
スポーツ肘関節障害，三次元CT

● Abstract

The purpose of this study was to evaluate the efficacy of three-dimensional (3D) computerized tomographic (CT) imaging in the diagnosis and treatment of sports injuries in the elbow joint.

In ten cases-including cases of 'baseball elbow', and of 'kendo elbow'-measurements were made using plain radiography, arthrography, bone scintigrams, CT imaging, 3D-CT imaging and magnetic resonance imaging (MRI).

3D-CT imaging was useful in studying the three-dimensional stereoscopic structure of the bone growth caused by osteophytes. This was helpful in planning for osteotomy. Although, 3D-CT imaging was not useful for determining changes in the articular cartilage and for diagnosis in cases of intra-articular free-floating bodies, we have reported the efficacy of tomography, bone scintigrams and MRI in these cases.

Our findings suggested that 3D-CT imaging would also be useful in pre-operation simulation studies.

● 要旨

本研究の目的は，スポーツによる肘関節障害に対して有効な診断法を検索することであり，そのなかで三次元CTに着目し，その有用性について検討を行った。

野球肘，剣道肘を含む10症例に対し，単純X線，骨シンチグラフィ，CTおよび三次元CT，関節造影ならびにMRIを施行した。

三次元CTは，骨棘などによる増殖性骨変化の三次元的立体構造の把握や骨切りの治療計画に役立ったが，関節遊離体の診断には三次元CTと断層撮影を併用する必要があった。

三次元CT本来の威力を発揮すべき場所は，術前のシミュレーションであると考える。

平川 誠
〒222-0036 横浜市港北区小机町3211
横浜労災病院整形外科
TEL 045-474-8111/FAX 045-474-8323

Department of Orthopaedic Surgery,
Yokohama Rosai Hospital

Introduction

Previous reports in the orthopaedic literature on the usefulness of three-dimensional(3D)computerized tomographic(CT)imaging have mainly been concerning hip joints and spinal diseases[1~6]. We have previously used plain radiography, arthrography, tomography, CT imaging, 3D-CT imaging, magnetic resonance image(MRI)and bone scintigrams for the diagnosis of sports injuries in the elbow joint[7~9]. The purpose of the present study was to evaluate the efficacy of 3D-CT imaging in the diagnosis and treatment of the these injuries.

Subjects and methods

Ten athletes with a sports injury in the elbow joint have been visiting our clinic from August 1996. Six cases of 'baseball elbow' involved patients ranging from 17 to 31 years of age, with an average age of 22.7 years, and included members of a high school, university and professional baseball team. Another two cases involved a 22-year-old kendo player and

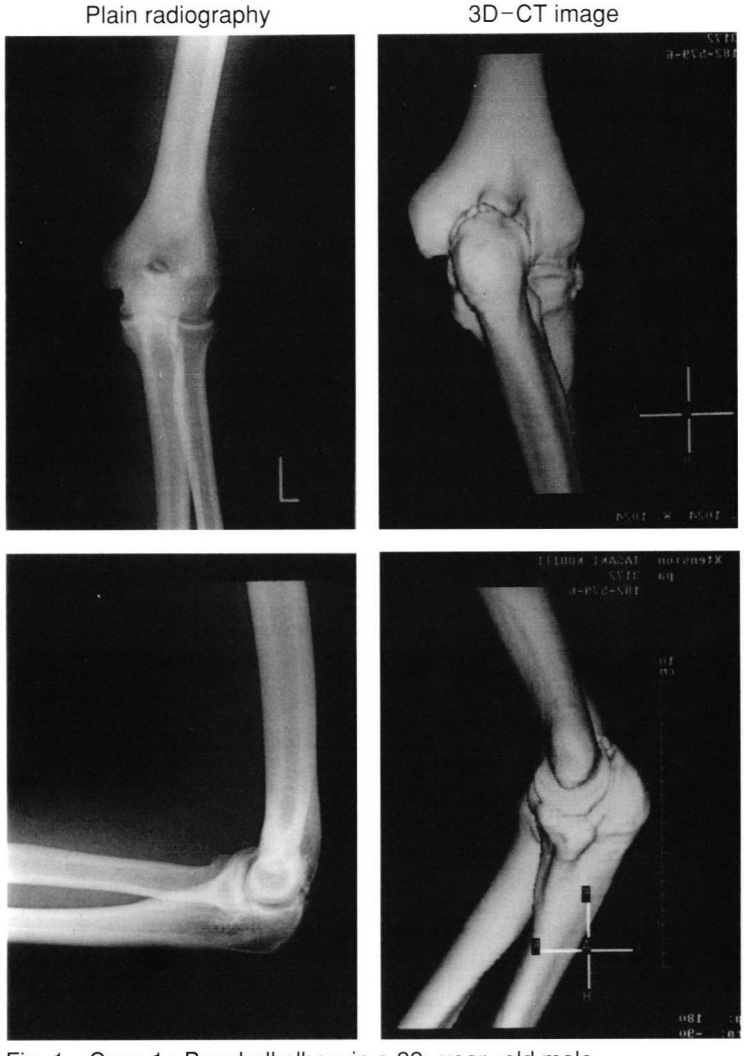

Fig. 1 Case 1 : Baseball elbow in a 22-year-old male.
3D-CT imaging showed the osteophyte to have been induced by a valgus force against the olecranon and the medial and lateral side of the elbow joint.

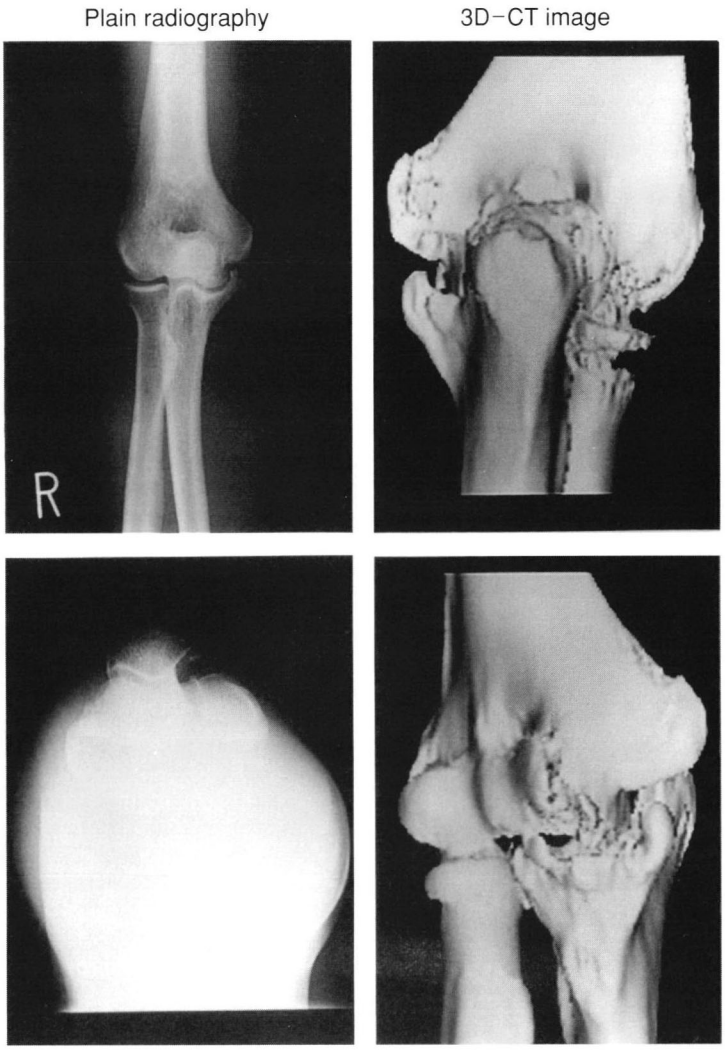

Fig. 2 Case 2 : Ulnar nerve palsy in a 47-year-old male.

a 20-year-old weight-lifter, and the other two cases involved patients both 47-year-old with ulnar nerve palsy.

In all cases, measurements were made using plain radiography, arthrography, CT imaging, 3D-CT imaging, MRI and bone scintigrams except in the case of ulnar nerve palsy for which the same techniques, excluding bone scintigrams, were used. Two cases with baseball elbow, the two with ulnar nerve palsy, and the one case of kendo elbow were surgically treated.

Case reports

Case 1 : This case is of a 22-year-old male baseball player. 3D-CT imaging showed the osteophyte to have been induced by a valgus force against the olecranon and the medial and lateral side of the elbow joint (Fig. 1).

Case 2 : This case is of a 47-year-old male with ulnar nerve palsy. 3D-CT imaging confirmed the finding of a remarkable change in the olecranon (Fig. 2).

Case 3 : This case is of a 22-year-old male kendo player. 3D-CT imaging confirmed the find-

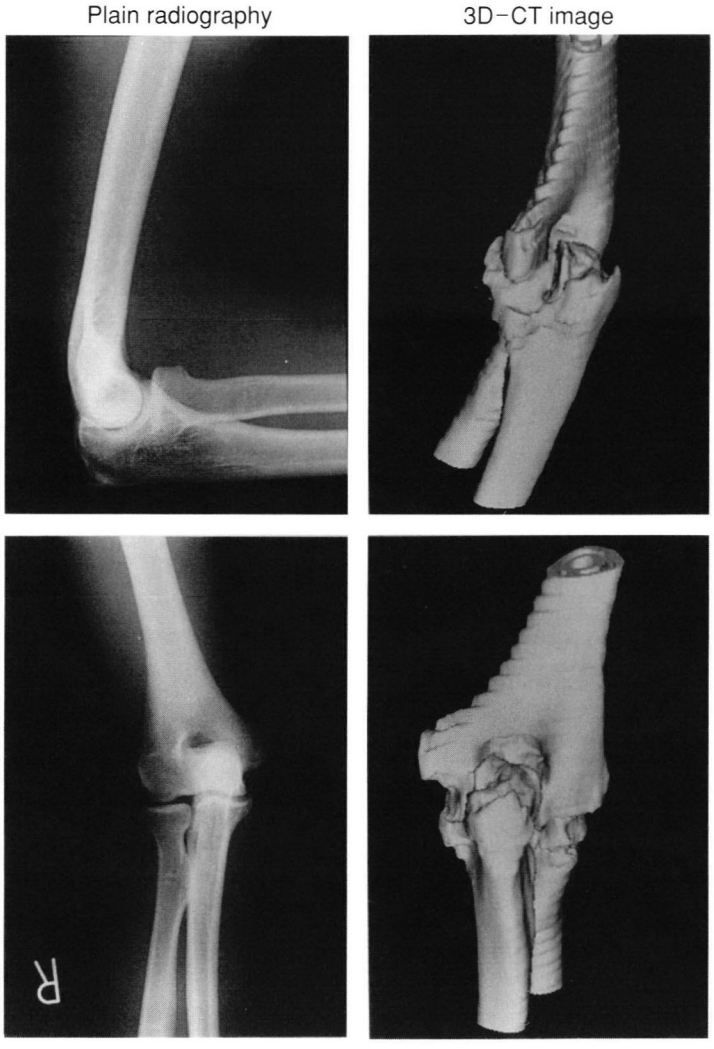

Fig. 3 Case 3 : Kendo elbow in a 22-year-old male.
It was considered that the horizontal lines that appeared in the 3D-CT imaging were due to the stair-step artifact.

ing of a remarkable change in the olecranon in comparison with the radiography taken a year before. 3D-CT imaging revealed an osteophyte growth in the back and medial side of the olecranon. It was considered that the horizontal lines that appeared in the 3D-CT imaging were due to the stair-step artifact(Fig. 3).

Case 4 : This case is of a 17-year-old male baseball player. There was pain in the medial side of the elbow joint and the olecranon. Bone scintigrams demonstrated an increased uptake in the medial side of the epicondylus. However, the 3D-CT imaging did not show any evidence of this(Fig. 4). Although it was undetected in the 3D-CT imaging, fibrocartilage was found during surgery. 3D-CT imaging was not suitable for confirming changes in the articular cartilage and enthesopathy, as expected.

Case 5 : This case is of a 26-year-old male baseball player. The injury was located in the medial collateral ligament of the elbow joint and was diagnosed with an avulsion fracture. 3D-CT imaging showed bone fragments appearing as small dots. We performed reconstructive surgery using the palmaris longus(Fig. 5).

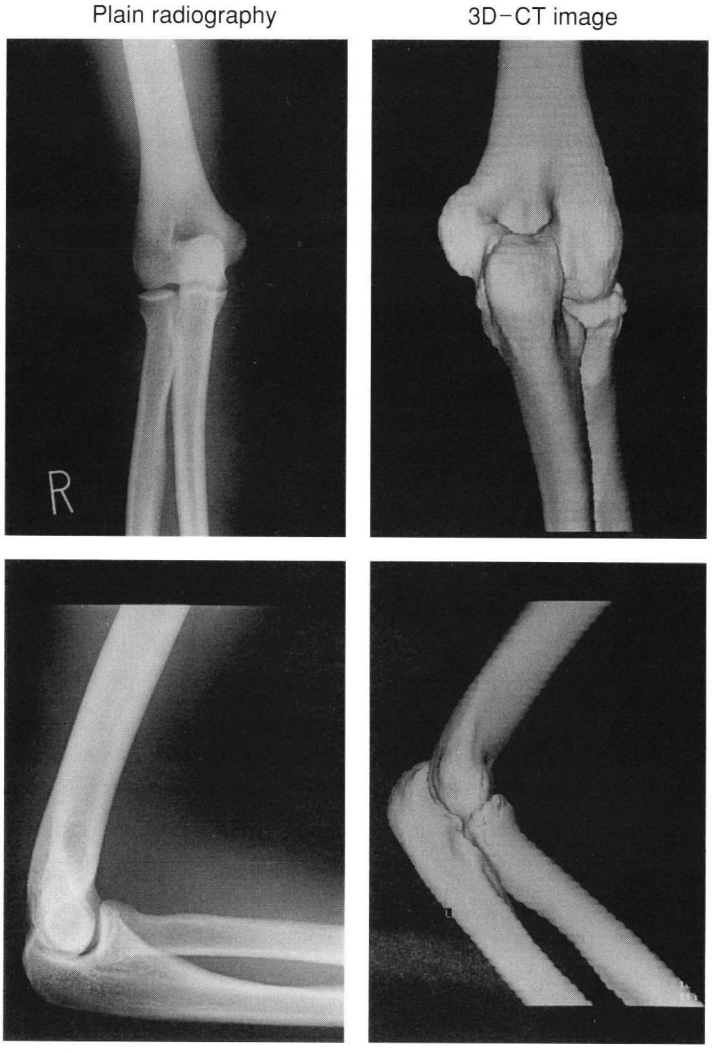

Fig. 4 Case 4 : Baseball elbow in a 17-year-old male.

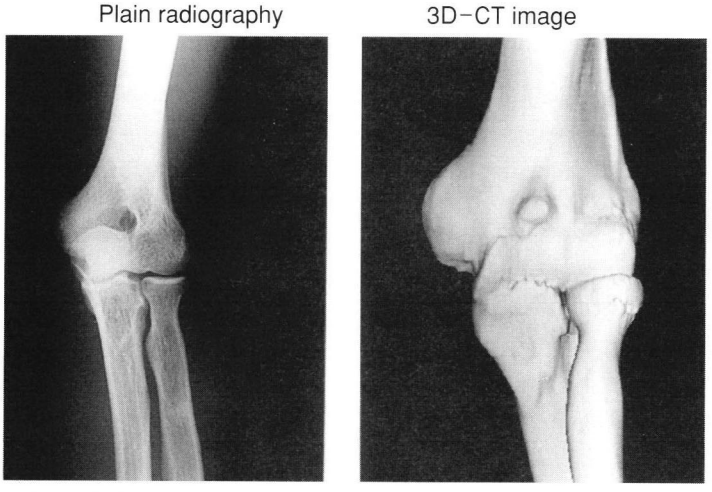

Fig. 5 Case 5: Baseball elbow in a 26-year-old male.
3D-CT imaging showed bone fragments appearing as small dots.

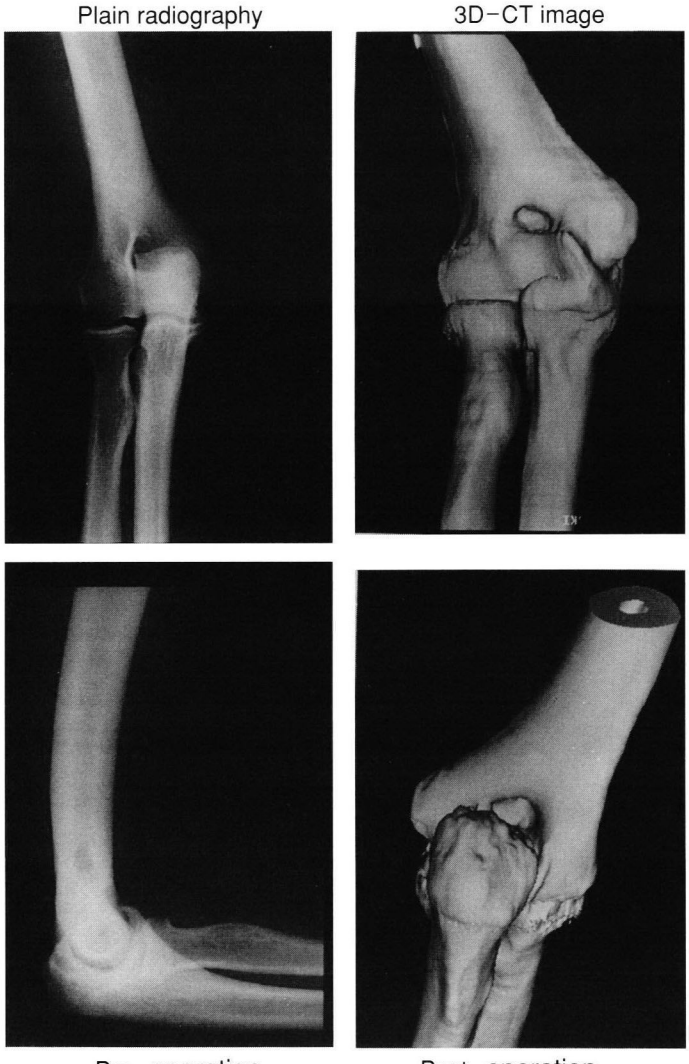

Fig. 6 Case 6: Baseball elbow in a 31-year-old male professional player.
Second operation became necessary due to an excessive use of the previously operated area. In this case, we repeated the operation according to the findings from the 3D-CT imaging taken after the first operation.

Case 6 : This case is of a 31-year-old male who was a professional baseball player. Fig. 6 shows the findings from a pre-operation plain radiogram and a post-operation 3D-CT imaging. Second operation became necessary due to an excessive use of the previously operated area. In this case, we repeated the operation according to the findings from the 3D-CT imaging taken after the first operation (Fig. 6).

Discussion

In comparison to the planned excision of osteophyte growth in the radiographic image, the actual excision during the operation was narrower. 3D-CT imaging was useful in studying the three-dimensional stereoscopic structure of the bone growth caused by osteo-

phytes or similar abnormality. This was helpful, particularly in cases for inexperienced surgeons. Considering this, our findings suggested that 3D-CT imaging can be useful in simulating osteotomy pre-operatively as well. Moreover, we have demonstrated improved efficacy when plain radiography and tomography are used together.

Although, 3D-CT imaging was not useful for determining any change in the articular cartilage or intra-articular free-floating bodies, we have found 3D-CT imaging to be useful when combined with tomography, bone scintigram and MRI.

Conclusion

1. We have studied the usefulness of 3D-CT imaging in ten patients who had an injury in the elbow joint from a sports activity.
2. 3D-CT imaging was considered to be not useful for evaluating the articular surface.
3. It was required to use both 3D-CT imaging and tomography when diagnosing intra-articular free-floating bodies.
4. These findings suggested that 3D-CT imaging would also be useful when determining the excision of osteophyte growth in pre-operative planning.

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Japanese Journal of ORTHOPAEDIC SPORTS MEDICINE

日本整形外科スポーツ医学会

日本整形外科スポーツ医学会会則

第1章　総　　則

第1条　名称

本会の名称は、日本整形外科スポーツ医学会（The Japanese Orthopaedic Society for Sports Medicine）略称、JOSSMという

以下、本会という

第2条　事務局

本会の事務局は、理事会の議により定めた場所に置く

第2章　目的および事業

第3条　目的

本会は、整形外科領域におけるスポーツ医学並びにスポーツ外傷と障害の研究の進歩・発展を目的とし、スポーツ医学の向上とスポーツの発展に寄与する

第4条　事業

本会は、第3条の目的達成のために次の事業を行なう

1）学術集会の開催

2）機関誌「日本整形外科スポーツ医学会雑誌」（Japanese Journal of Orthopaedic Sports Medicine）の編集・発行

3）内外の関係学術団体との連絡および提携

4）その他、前条の目的を達成するに必要な事業

第3章　会　　員

第5条　会員の種類

本会の会員は、次のとおりとする

1）正 会 員　本会の目的に賛同し、所定の登録手続きを行なった医師

2）準 会 員　本会の目的に賛同し、所定の登録手続きを行なった正会員以外のもの

3）特別会員　現在および将来にわたり本会の発展に寄与する外国人医師

4）名誉会員　下記の①、②をみたすもの

①本会の発展のために、顕著な貢献をした正会員および外国の医師のうちから、理事長が理事会および評議員会の議を経て推薦するもの

②70歳を越えているもの

5）賛助会員　本会の目的に賛同し、所定の手続きを行なった個人または団体

6）臨時会員　上記1～4の会員ではなく、本会の学術集会に出席し、会場費を支払った個人または団体

会員期間は、その学術集会の期間とする

第6条　入会

本会の正会員、準会員または賛助会員として入会を希望するものは、所定の用紙に記入の上、会費をそえて、本会事務局に申し込むものとする

入会資格は別に定める

但し、特別会員および名誉会員に推薦された者は、入会の手続きを要せず、本人の承諾をもって、会員となりかつ会費を納めることを要しない

第7条　退会

1）会員が退会しようとするときは、本会事務局に届けなければならない

2）会費を2年以上滞納した場合には、退会したものとみなす

第8条　除名

本会の名誉を傷つけ、また本会の目的に反する行為のあった場合、理事会は会員を除名することができる

第4章　役員，評議員

第9条　役員

本会には、次の役員を置く

1）理　事　若干名を置く（うち理事長1名、常任理事若干名）

2）監　事　2名

第10条　役員の選出

1）理事長および常任理事は、理事会において理事の中から選出する

2）理事および監事は、評議員の中から選出し、総会の承認を要する

第11条　役員の業務

1）理事長は、会務を統括し本会を代表する

2）理事は、理事会を組織し重要事項を審議、決定する

3）常任理事は、理事長を補佐し常務を処理する

4）監事は、本会の会計および会務を監査する

第12条　役員の任期

役員の任期は1期3年とし、再任は妨げない

但し、連続して2期6年を越えることはできない

第13条　評議員

1）本会には50名以上150名以内の評議員を置く

2）評議員は正会員の中から選出する

3）評議員は評議員会を組織して、本会役員の選出を行なうほか、理事会に助言する

4）評議員の任期は3年とし、再任は妨げない

第5章　委 員 会

第14条　委員会

理事会は必要に応じて、委員会を設けることができる

第6章　会　　議

第15条　理事会

1）理事会は理事長がこれを召集し、主宰する

2）会長は理事会に出席できる

第16条　総会および評議員会

1）総会は正会員および準会員をもって組織する

2）総会および評議員会は、それぞれ年1回学術集会開催中に開催する

3）総会および評議員会の議長は、理事長または、理事長の指名した者とする

4）臨時総会および臨時評議員会は必要に応じて、理事長がこれを召集できる

第７章　学術集会

第17条　学術集会

1）学術集会は年１回開催し、会長がこれを主宰する

2）会長、次期会長は理事会の推薦により、評議員会および総会の承認を経て決定する

3）学術集会での発表の主演者および共同演者は、原則として本会の正会員に限る

第８章　会費および会計

第18条　正会員、準会員および賛助会員の年会費は別に定める

第19条　本会の経費は会費、および寄付金その他をもってこれに当てる

第20条　本会の目的に賛同する個人および団体から寄付金を受けることができる

第21条　本会の収支予算および決算は理事会の決議を経て評議員会、総会の承認を得なければならない

第22条　既納の会費は、これを返還しない

第23条　本会の会計年度は、４月１日に始まり、翌年の3月31日に終わる

第９章　附　　則

第24条　本会則の改正は、評議員会において、出席者の過半数以上の同意を必要とし、総会の承認を要する

当分の間、本会の事務局は東京都港区元麻布三丁目1番38号 4B
有限会社ヒズ・ブレイン内に置く

附　記　本会則は、昭和57年６月５日から施行する
本改正会則は、昭和63年４月１日から施行する
本改正会則は、平成４年６月１日から施行する
本改正会則は、平成６年６月17日から施行する
本改正会則は、平成９年５月17日から施行する
本改正会則は、平成10年９月12日から施行する

名誉会員・特別会員

青木　虎吉	高岸　直人	Bernard R. Cahill
今井　　望	津山　直一	Wolf-Dieter Montag
榊田喜三郎	鞆田　幸徳	W. Pforringer
鈴木　良平	鳥山　貞宣	George A Snook

理　　事

◎井形　高明	○石井　清一	田島　直也	原田　征行
生田　義和	高澤　晴夫	中嶋　寛之	守屋　秀繁

◎理事長　○常任理事

監　　事

東　　博彦　　藤巻　悦夫

評 議 員

青木　治人	城所　靖郎	須川　　勲	乗松　尋道	宮川　俊平
赤松　功也	栗山　節郎	菅原　　誠	初山　泰弘	宮津　　誠
阿曽沼　要	黒坂　昌弘	勝呂　　徹	濱　　弘道	宮永　　豊
阿部　正隆	黒澤　　尚	高尾　良英	林　浩一郎	武藤　芳照
有馬　　亨	古賀　良生	高木　克公	平澤　泰介	茂手木三男
井上　　一	腰野　富久	高岸　憲二	廣橋　賢次	森　雄二郎
今井　立史	小山　由喜	高倉　義典	福田　眞輔	安田　和則
今給黎篤弘	斎藤　明義	竹下　　満	福田　宏明	矢部　　裕
入江　一憲	左海　伸夫	竹田　　毅	福林　　徹	山本　博司
上崎　典雄	阪本　桂造	田島　　寶	冨士川恭輔	山本　龍二
大久保　衛	桜庭　景植	立花　陽明	藤巻　悦夫	横江　清司
岡崎　壮之	酒匂　　崇	田中　寿一	古府　照男	吉松　俊一
岡村　良久	佐々木良介	田渕　健一	星川　吉光	龍　順之助
越智　隆弘	佐藤　光三	土屋　正光	増島　　篤	若野　紘一
越智　光夫	史野　根生	戸松　泰介	松井　宣夫	渡會　公治
柏口　新二	柴田　大法	冨永　積生	松崎　昭夫	
加藤　哲也	霜　礼次郎	丹羽　滋郎	圓尾　宗司	
菊地　臣一	白井　康正	乗松　敏晴	三浦　隆行	（敬称略）

学術集会について

第25回日本整形外科スポーツ医学会学術集会

第25回日本整形外科スポーツ医学会学術集会の演題を募集いたします。演題の申し込みは日本整形外科スポーツ医学会雑誌18巻4号に綴じ込まれている抄録用紙をご使用下さい。

なお演題の採否及び発表形式は会長にご一任下さい。

記

会　期：1999年5月28日(金)・29日(土)
会　場：神戸国際会議場ほか

内　容：1) シンポジウム
1. スポーツ選手腰部ヘルニアへの手術法の選択
2. スポーツ選手の手部傷害の治療

2) 一般演題（口演，展示発表）
競技別，部位別にパネル形式の発表を予定しています。

演題申し込み締め切り：1998年12月18日(金)消印有効

送付先：〒663-8501　西宮市武庫川町1-1
兵庫医科大学整形外科学教室内
第25回日本整形外科スポーツ医学会学術集会事務局
TEL 0798-45-6452/FAX 0798-45-6453

第25回日本整形外科スポーツ医学会学術集会
会長　圓尾宗司

報告とお知らせ

会　告

1998年10月21日

日本整形外科スポーツ医学会
理事長　井　形　高　明

事務局の移転について

標記の件，1998年9月11日に開催されました総会におきまして，下記の通り決定いたしましたのでお知らせいたします。

記

日本整形外科スポーツ医学会事務局
〒106-0046　東京都港区元麻布3-1-38 4B
有限会社 ヒズ・ブレイン内
TEL 03-3401-6511/FAX 03-3401-6526

会　告

1998年10月21日

日本整形外科スポーツ医学会
理事長　井　形　高　明
国際委員会 担当理事　生　田　義　和
田　島　直　也

1999年度(第9回)
JOSSM/KOSSM/GOTS Travelling Fellow募集

1999年度日本整形外科スポーツ医学会が派遣するTravelling Fellow 2名を以下の要項に基づき公募いたします。なお，Fellowには学術集会での発表が求められております。また，日本整形外科スポーツ医学会からは旅費援助として150,000円が支給されます。

募　集　要　項

1．応募資格　①日本整形外科スポーツ医学会の正会員
②年齢35歳～45歳(1998年9月21日現在)
③スポーツ医学に関する業績があり，研究論文の発表があること
2．募集人員　2名　(韓国整形外科スポーツ医学会から2名)
3．期　　間　1999年5月30日(日)～6月27日(日)(4週間)
4．訪 問 先　ヨーロッパ各地の大学，病院，施設(整形外科全般)
5．論文発表　学会(GOTS)での演題発表のほか各訪問先で討論等に参加
6．費　　用　①航空運賃は各自負担
②現地での滞在費は，原則としてGOTSが負担
③旅費援助として150,000円支給
7．提出書類　次の書類を提出してください。なお書式は事務局宛ご請求ください。
①応募申込書
②履歴書(英文，写真貼付)
③研究業績一覧(論文，学会発表)
④日本整形外科スポーツ医学会評議員の推薦書
8．選定方法　日本整形外科スポーツ医学会国際委員会において審査，選考，
理事会において審議，決定します。
9．応募締切　1998年11月30日(月) 事務局必着
10．送 付 先　日本整形外科スポーツ医学会事務局
〒106-0046 東京都港区元麻布3-1-38 4B　有限会社 ヒズ・ブレイン内
TEL 03-3401-6511/FAX 03-3401-6526

日本整形外科スポーツ医学会
1998年度 第2回理事会 議事録

日　時：1998年9月10日(木)10：00～11：00
場　所：八ヶ岳ロイヤルホテル 1Fシリウス
出席者：理事：井形　高明，石井　清一，生田　義和，高澤　晴夫，
田島　直也，中嶋　寛之，原田　征行，守屋　秀繁
監事：東　博彦，藤巻　悦夫
学術集会長：赤松 功也　　次期学術集会長：圓尾 宗司
事務局（2名）

1．理事長挨拶

2．97年度庶務・会計報告
石井常任理事から資料に基づき説明がなされた後，審議の結果原案どおり承認した。

3．98年度予算案
石井常任理事から資料に基づき説明がなされた後，審議の結果原案どおり承認した。
また，理事会は①賛助会員，②資産の運用，について事務局に調査･検討を指示した。

4．第24回学術集会報告
赤松会長が，9月10日(木)～9月12日(土)まで八ヶ岳ロイヤルホテルで開催する標記学術集会の運営について報告した。

5．第25回学術集会報告
圓尾次期会長が，1999年5月28日(金)，29日(土)の両日，神戸国際会議場ほかで開催する標記学術集会の準備進行状況について報告した。

6．事務局移転，会則改正に関する件
石井常任理事より，まず事務局移転の経緯についての説明があった後，有限会社ヒズ・ブレインへの業務委託について審議し，これを了承した。次いで会則改正(案)について，原田理事(会則等検討委員会担当)，石井常任理事(庶務委員会担当)から経緯の説明があり，審議の結果，原案どおりこれを承認した。
(現行条文)
第2条　事務局
本会の事務局を横浜市中区新山下3-2-3
横浜市立港湾病院内に置く

（改正条文）

第２条　事務局

本会の事務局は，理事会の議により定めた場所に置く

附　則　当分の間，本会の事務局は東京都港区元麻布三丁目１番38号 4B 有限会社ヒズ・ブレイン内に置く

7．新評議員の推薦に関する件

井形理事長から，経緯の説明がなされた後，審議の結果，今回推薦された候補者の中から下記の会員を新評議員として選出した。

高岸　憲二先生（群馬大学医学部整形外科学教室 教授）
冨士川恭輔先生（防衛医科大学校整形外科学教室 教授）
濱　　弘道先生（京都大学医療技術短期大学 教授）
柏口　新二先生（徳島大学医学部整形外科学教室 講師）

次いで，評議員の定数に関して討議した。定数増を支持する意見が大半であったため，下記の会則変更（案）を審議した結果，会則を改正することを承認した。

（現行条文）

第13条　評議員

1）本会には50名以上100名以内の評議員を置く

2）～4）略

（改正条文）

第13条　評議員

1）本会には50名以上150名以内の評議員を置く

2）～4）略

なお，地域バランス等を考慮した新評議員の選出方法については，今回推薦された評議員を含めて，改めて会則等検討委員会が検討することとなった。

8．各種委員会からの報告と提案

1）庶務委員会［石井常任理事］

事務局移転に関する件，および学会活性化につき検討したとの報告があった。

2）国際委員会［生田・田島理事］

①98年度JOSSM/KOSSM/GOTS Travelling Fellowshipについて

標記Travelling Fellowとして，ドイツ，オーストリア，スイスから合計4名が8月31日に来日，千葉大学，徳島大学，神戸大学，広島大学を訪問，今回の学術集会で発表後は筑波大学を訪問し，9月13日離日予定との報告があった。

②99年度JOSSM/KOSSM/GOTS Travelling Fellow選出について
標記募集要項および内規(案)について説明があり，審議の結果これを了承した。また，本募集要項は，会員全員に配布することを了承した。

③第5回日韓整形外科スポーツ医学会について
討議の結果，今後の対応については理事長に一任したいとの報告があり，これを了承した。

3）学術検討委員会［守屋理事］
①平成9年度(財)日本スポーツ治療医学研究会研究助成について
標記の件につき，16件の申込について優先順位を選考し，申請の結果，本年度は下記のとおり助成が決定したとの報告があった。

研究助成対象課題および研究者
1．主たる研究者名　山下　敏彦（札幌医科大学整形外科講師）
2．課　題　名　関節の固有感覚受容器に関する電気生理学的研究
3．金　　額　500,000円

②全国医学部スポーツドクター協議会について
標記協議会で医学部学生のラグビー外傷について現在調査中であり，結果をできるだけ早くまとめ，本学会で報告したいとの報告があった。

4）会則等検討委員会［原田理事］
事務局移転に伴う会則の改正について検討したとの報告があった。

5）広報委員会［中嶋理事］
97年度より会員への情報提供として，学会雑誌に理事会の議事録を掲載したとの報告があった。
また，理事会は会員サービスの一環として，インターネットのホームページの開設およびニュースレターを発行することを了承し，広報委員会に詳細な検討を依頼した。

6）編集委員会［石井常任理事］
①雑誌発刊状況について報告があった。
②現編集委員の任期を延長したい旨の申入れがあり，理事会はこれを了承した。
③学術集会の特別講演，教育研修講演等について学会雑誌に掲載したい旨の申入れがあり，理事会はこれを了承した。
④雑誌Vol.19掲載用論文の公募状況について報告があった。

9．その他

1）Best Paper of the Yearについて

石井常任理事からこれまでの経緯と現状について報告がなされた後，討議の結果，圓尾第25回学術集会会長に検討を依頼した。

2）旧事務局員の退職慰労金について

石井常任理事からこれまでの経緯と現状について報告がなされた後，討議の結果，李職員には100,000円，佐々木職員には50,000円が支給されることとなった。

3）本学会の活性化，今後の活動方針および診療報酬や標榜科名を中心としたスポーツ医療の問題点等について，積極的に検討していくことを確認した。

以上

日本整形外科スポーツ医学会 1997年度 収支計算書

（1997年4月1日から1998年3月31日まで）

【収入の部】　　（単位：円）

科　　目	1997年度予算額	1997年度決算額	差　異
1．年会費収入	16,800,000 ※1	16,956,000 ※2	△156,000
賛助会費収入	800,000	0	800,000
2．雑誌掲載料収入	600,000	1,021,000	△421,000
3．広告掲載料収入	400,000	660,000	△260,000
4．雑収入	50,000	16,172	33,828
当期収入合計　①	18,650,000	18,653,172	△3,172
前期繰越収支差額	19,881,226	19,881,226	0
収入合計　②	38,531,226	38,534,398	△3,172

※1　12,000円×1,400名　　※2　12,000円×1,413名

【支出の部】

科　　目	1997年度予算額	1997年度決算額	差　異
1．学会雑誌発行費	7,900,000	9,444,191 ※3	△1,544,191
印刷費（4冊）	(7,000,000)	(7,959,668)	△959,668
発送費	(700,000)	(1,016,925)	△316,925
発送用封筒等印刷費	(200,000)	(467,598)	△267,598
2．学術集会開催費負担金	1,000,000	1,000,000	0
3．委員会費	1,500,000	1,000,735	499,265
4．理事会費	500,000	115,385	384,615
5．国際学術交流関係費	1,500,000	900,000	600,000
6．運営費	5,150,000	6,122,498	△972,498
人件費	(2,800,000)	(1,865,725)	934,275
交通費	(400,000)	(253,850)	146,150
事務委託費	(0)	(2,208,045)	△2,208,045
印刷製本費	(300,000)	(291,050)	8,950
通信費	(1,200,000)	(1,139,031)	60,969
消耗品費	(300,000)	(170,274)	129,726
雑費	(150,000)	(194,523)	△44,523
小　　計	17,550,000	18,582,809	△1,032,809
7．予備費	0	0	0
当期支出合計　③	17,550,000	18,582,809	△1,032,809
当期収支差額　①－③	1,100,000	70,363	1,029,637
次期繰越収支差額②－③ ※4	20,981,226	19,951,589	1,029,637
支出合計	38,531,226	38,534,398	△3,172

※3 当期は 18.1号を含めたため、4冊分計上されています。

※4 次期繰越収支差額の内容：現金預金、未収入金及び△未払金、△仮受金

財　産　目　録

（1998年3月31日　現在）　　（単位：円）

【資産の部】		
Ⅰ　流動資産		
1　現金及び預金		
現金	130,185	
三和銀行横浜支店	7,905,599	
さくら銀行横浜駅前支店	16,545,278	24,581,062
2　その他の流動資産		
未収入金（雑誌掲載料等）	94,000	94,000
流動資産合計		24,675,062
資　産　合　計		24,675,062

【負債の部】		
Ⅰ　流動負債		
1　未払金		
学会雑誌印刷費	1,799,648	
発送用封筒等印刷費	208,950	
発送費	205,098	
その他の印刷費	73,500	
通信費	148,232	
事務委託費	2,208,045	4,643,473
2　仮受金	80,000	80,000
流動負債合計		4,723,473
負　債　合　計		4,723,473

正　味　財　産	19,951,589

正味財産増減計算書

（1997年4月1日から1998年3月31日まで）　　（単位：円）

科　　目	金　　額	
1　期首正味財産		19,881,226
2　当期収入の部合計　①	18,653,172	
3　当期支出の部合計　②	18,582,809	
4　当期収支差額　①－②		70,363
5　期末正味財産		19,951,589

日本整形外科スポーツ医学会 1998年度 収支予算案

（1998年4月1日から1999年3月31日まで）

【収入の部】　（単位：円）

科　目	1997年度予算額	1998年度予算案	差　異
1．年会費収入	16,800,000 ※1	17,040,000 ※2	△240,000
賛助会費収入	800,000	0	800,000
2．雑誌掲載料収入	600,000	1,000,000	△400,000
3．広告掲載料収入	400,000	600,000	△200,000
4．雑収入	50,000	20,000	30,000
当期収入合計　①	18,650,000	18,660,000	△10,000
前期繰越収支差額	19,881,226	19,951,589	△70,363
収入合計　②	38,531,226	38,611,589	△80,363

※1　12,000円×1,400名　　※2　12,000円×1,420名

【支出の部】

科　目	1997年度予算額	1998年度予算案	差　異
1．学会雑誌発行費	7,900,000	7,900,000	0
印刷費（3冊）	(7,000,000)	(7,000,000)	0
発送費	(700,000)	(700,000)	0
発送用封筒等印刷費	(200,000)	(200,000)	0
2．学術集会開催費負担金	1,000,000	1,000,000	0
3．委員会費	1,500,000	1,500,000	0
4．理事会費	500,000	500,000	0
5．国際学術交流関係費	1,500,000	1,500,000	0
6．運営費	5,150,000	4,450,000	700,000
人件費	(2,800,000)	(0)	2,800,000
交通費	(400,000)	(200,000)	200,000
事務委託費	(0)	(2,300,000)	△2,300,000
印刷製本費	(300,000)	(300,000)	0
通信費	(1,200,000)	(1,200,000)	0
消耗品費	(300,000)	(300,000)	0
雑費	(150,000)	(150,000)	0
小　計	17,550,000	16,850,000	700,000
7．予備費	0	300,000	△300,000
当期支出合計　③	17,550,000	17,150,000	400,000
当期収支差額　①－③	1,100,000	1,510,000	△410,000
次期繰越収支差額②－③	20,981,226	21,461,589	△480,363
支出合計	38,531,226	38,611,589	△80,363

日本整形外科スポーツ医学会
1998年度 評議員会 議事録

日　時：1998年9月10日(木) 11:00～12:00
場　所：八ヶ岳ロイヤルホテル B1Fグランドホール

1. 理事長挨拶

2. 97年度庶務・会計報告
石井常任理事から資料に基づき説明がなされた後，審議の結果原案どおり承認した。

3. 98年度予算案
石井常任理事から資料に基づき説明がなされた後，審議の結果原案どおり承認した。

4. 第24回学術集会報告
赤松会長が，9月10日(木)～9月12日(土)まで八ヶ岳ロイヤルホテルで開催する標記学術集会の運営について報告した。

5. 第25回学術集会報告
圓尾会長が，1999年5月28日(金)，29日(土)の両日，神戸国際会議場ほかで開催する標記学術集会の準備進行状況について報告した。

6. 第26回学術集会報告
白井会長が，2000年5月18日(木)～20日(土)まで，東京国際フォーラムで開催する標記学術集会の準備進行状況について報告した。

7. 事務局移転，会則改正に関する件
石井常任理事より，会則改正(案)についての経緯を含めた説明があった後，挙手による採決の結果，絶対的多数により原案どおりこれを承認した。
(現行条文)
第2条　事務局
本会の事務局を横浜市中区新山下3-2-3
横浜市立港湾病院内に置く
(改正条文)
第2条　事務局
本会の事務局は，理事会の議により定めた場所に置く

附　則　当分の間，本会の事務局は東京都港区元麻布三丁目1番38号 4B
有限会社ヒズ・ブレイン内に置く

8．新評議員の推薦に関する件

井形理事長から，理事会での審議の結果，今回推薦された候補者の中から下記の会員を新評議員として選出した旨の報告があった。

高岸　憲二先生（群馬大学医学部整形外科学教室 教授）
冨士川恭輔先生（防衛医科大学校整形外科学教室 教授）
濱　　弘道先生（京都大学医療技術短期大学 教授）
柏口　新二先生（徳島大学医学部整形外科学教室 講師）

次いで，評議員の定数に関して理事会で下記の会則変更(案)を審議した結果，会則を改正することを承認した旨の説明があり，挙手による採決の結果，絶対的多数により原案どおりこれを承認した。

(現行条文)

第13条　評議員

1）本会には50名以上100名以内の評議員を置く

2）～4）略

(改正条文)

第13条　評議員

1）本会には50名以上150名以内の評議員を置く

2）～4）略

9．各種委員会からの報告と提案

1）庶務委員会［石井常任理事］

事務局移転に関する件，および学会活性化につき検討したとの報告があった。

2）国際委員会［生田理事］

①98年度JOSSM/KOSSM/GOTS Travelling Fellowshipについて
標記Travelling Fellowとして，ドイツ，オーストリア，スイスから合計4名が8月31日に来日，千葉大学，徳島大学，神戸大学，広島大学を訪問，今回の学術集会で発表後は筑波大学を訪問し，9月13日離日予定との報告があった

②99年度JOSSM/KOSSM/GOTS Travelling Fellow選出について
標記募集要項について報告があった。

③第5回日韓整形外科スポーツ国際会議について
現在理事会で調整中である旨の報告があった。

3）学術検討委員会［守屋理事］

①平成9年度(財)日本スポーツ治療医学研究会研究助成について

標記の件につき，本年度は下記のとおり助成が決定したとの報告があった。

研究助成対象課題および研究者

1. 主たる研究者名　　山下　敏彦（札幌医科大学整形外科講師）
2. 課　題　名　　関節の固有感覚受容器に関する電気生理学的研究
3. 金　　額　　500,000円

②全国医学部スポーツドクター協議会について

標記協議会で医学部学生のラグビー外傷について，現在調査中であり，結果をできるだけ早くまとめ，本学会で報告したいとの報告があった。

4）会則等検討委員会［原田理事］

事務局移転に伴う会則の改正について検討したとの報告があった。

5）広報委員会［中嶋理事］

97年度より会員への情報提供として，学会雑誌に理事会の議事録を掲載した。また，今後会員サービスの一環として，インターネットのホームページの開設およびニュースレターを発行していく旨の報告があった。

6）編集委員会［石井常任理事］

①雑誌発刊状況について報告があった。

②現編集委員の任期の延長についての報告があった。

③学術集会の特別講演，教育研修講演等の学会雑誌への掲載が，理事会で承認された旨の報告があった。

④雑誌Vol.19掲載用論文の公募状況について報告があった。

10．その他

1）Best Paper of the Yearについて

井形理事長から，圓尾第25回学術集会会長に検討を依頼した旨の報告があった。

2）井形理事長より，本学会の活性化，今後の活動方針および診療報酬や標榜科名を中心としたスポーツ医療の問題点等について，理事会を中心に積極的に検討していくとの報告があった。

以上

日本整形外科スポーツ医学会
1998年度　総　会　議事録

日　時：1998年9月11日(金) 13:30～13:50
場　所：八ヶ岳ロイヤルホテル B1Fロイヤルホール

1. 理事長挨拶

2. 97年度庶務・会計報告
石井常任理事から資料に基づき説明がなされた後，原案どおり承認された。

3. 98年度予算案
石井常任理事から資料に基づき説明がなされた後，原案どおり承認された。

4. 第24回学術集会報告
赤松会長が，9月10日(木)～9月12日(土)まで八ヶ岳ロイヤルホテルで開催する標記学術集会の運営について報告した。

5. 第25回学術集会報告
圓尾会長が，1999年5月28日(金)，29日(土)の両日，神戸国際会議場ほかで開催する標記学術集会の準備進行状況について報告した。

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7. 会則改正に関する件
井形理事長より，会則改正(案)2件についての経緯を含めた説明があった後，挙手による採決の結果，絶対的多数により原案どおりこれを承認した。

(現行条文)

第2条　事務局
本会の事務局を横浜市中区新山下3-2-3
横浜市立港湾病院内に置く

(改正条文)

第2条　事務局
本会の事務局は，理事会の議により定めた場所に置く

附　則　当分の間，本会の事務局は東京都港区元麻布三丁目1番38号 4B
有限会社ヒズ・ブレイン内に置く。

（現行条文）
第13条　評議員
1）本会には50名以上100名以内の評議員を置く
2）～4）略
（改正条文）
第13条　評議員
1）本会には50名以上150名以内の評議員を置く
2）～4）略

8．新評議員の推薦に関する件

井形理事長から，理事会での審議の結果，今回推薦された候補者の中から下記の会員を新評議員として選出した旨の報告があった。

高岸　憲二先生（群馬大学医学部整形外科学教室 教授）
冨士川恭輔先生（防衛医科大学校整形外科学教室 教授）
濱　　弘道先生（京都大学医療技術短期大学 教授）
柏口　新二先生（徳島大学医学部整形外科学教室 講師）

9．各種委員会からの報告と提案

井形理事長が，各委員会の活動について下記の通り報告した。

1）庶務委員会

事務局移転に関する件および学会活性化につき検討した。

2）国際委員会

①98年度JOSSM/KOSSM/GOTS Travelling Fellowshipについて
標記Travelling Fellowとして，ドイツ，オーストリア，スイスから合計4名が8月31日に来日，千葉大学，徳島大学，神戸大学，広島大学を訪問，今回の学術集会で発表後は筑波大学を訪問し，9月13日離日予定である。
②99年度JOSSM/KOSSM/GOTS Travelling Fellow選出について
標記募集要項について近日中に全学会員宛発送予定である。
③第5回日韓整形外科スポーツ国際会議について
現在理事会で調整中である。

3）学術検討委員会

①平成9年度(財)日本スポーツ治療医学研究会研究助成について
標記の件につき，本年度は下記の通り助成が決定した。

研究助成対象課題および研究者

1. 主たる研究者名　　山下　敏彦（札幌医科大学整形外科講師）
2. 課　　題　　名　　関節の固有感覚受容器に関する電気生理学的研究
3. 金　　額　　500,000円

②全国医学部スポーツドクター協議会について

標記協議会で医学部学生のラグビー外傷について現在調査中であり，結果をできるだけ早くまとめ，本学会で報告する予定である。

4）会則等検討委員会

事務局移転に伴う会則の改正について検討した。

5）広報委員会

97年度より会員への情報提供として，学会雑誌に理事会の議事録を掲載した。また，今後会員サービスの一環として，インターネットのホームページの開設およびニュースレターの発行を行なう。

6）編集委員会

①雑誌発刊状況について報告した。

②学術集会の特別講演，教育研修講演等の学会雑誌への掲載が，理事会で承認された。

③雑誌Vol.19掲載用論文の公募状況を説明し，積極的投稿を要請した。

10．その他

1）Best Paper of the Yearについて

井形理事長から，圓尾第25回学術集会会長に検討を依頼した旨の報告があった。

2）井形理事長より，本学会の活性化，今後の活動方針，および診療報酬や標榜科名など，将来のスポーツ医療の問題点等について，理事会を中心に積極的に検討していくとの報告があった。

学会開催のお知らせ

第16回中部日本手の外科研究会

第16回中部日本手の外科研究会を下記により開催いたします。多くの方々のご参加をお願いいたします。

記

会　期：1999年1月30日(土)

会　場：くにびきメッセ

〒690-0823　島根県松江市西川津町3669

TEL 0852-24-1111

予定シンポジウムおよび主題：

1) 腕神経叢麻痺の診断と治療

2) リウマチ手の治療

3) 手根管症候群の治療

特別講演：The Diagnosis and Treatment of Brachial Plexus Injury(仮題).

Thomas Carlstedt, M. D.

The Royal National Orthopaedic Hospital, Middlesex, England.

連絡先：〒639-8501　島根県出雲市塩冶町89-1

島根医科大学整形外科学教室

第16回中部日本手の外科研究会事務局

TEL 0853-20-2242/FAX 0853-20-2236

＊本研究会は会員制となっています。主演者および共同演者の入会申し込み並びに本年度の会費納入は本部事務局(広島大学医学部整形外科学教室)に直接ご連絡ください。

第16回中部日本手の外科研究会

会長　越智光夫

(島根医科大学整形外科学教室)

第20回東京膝関節学会

会　期：1999年2月20日(土)
会　場：シェーンバッハ・サボー
〒102-0093　東京都千代田区平河町2-7-5
TEL : 03-3261-8386

教育研修講演

膝関節の滑膜の形態と機能(仮題)

Dr. E. F. Dicarlo
Attending Pathologist,
Department of Laboratory Medicine,
Hospital for Special Surgery, New York

演　題

1．主題

(1) 膝複合靱帯損傷の治療
(2) 半月板修復術の中長期成績
(3) 膝関節拘縮の治療法とその成績　特に鏡視下手術の適応と限界

2．一般演題

事務局：〒321-0293　栃木県下都賀郡壬生町北小林880
獨協医科大学整形外科学教室内
第20回東京膝関節学会事務局
TEL 0282-87-2161(直通) / FAX 0282-86-5422(直通)

第20回東京膝関節学会
会長　早乙女 紘一
(獨協医科大学整形外科)

第13回日本靴医学会

募集要項，抄録用紙は日本靴医学会雑誌（11巻）に綴じ込まれています。募集要項に則りご応募ください。日本靴医学会に未加入の方は下記連絡先にご請求ください。

記

会　期：1999年6月17日(木)
会　場：コクヨホール（東京，品川駅港南口より徒歩1分）

演　題：以下のテーマを中心に，シンポジウム，主題，一般演題，ポスターを募集します。採否，発表の形式は会長にご一任ください。

1. スポーツと靴　成績向上と障害防止
2. ファッションと医療の接点　外反母趾　糖尿病足　扁平足など
3. 日本人にとっての靴　欧米との違い
4. 靴と年齢　各世代に求められる靴

演題締め切り：1999年2月28日(日)(消印有効)

連絡先：〒160-8582　東京都新宿区信濃町35
慶應義塾大学医学部整形外科学教室内
第13回日本靴医学会事務局
TEL 03-3353-1211(内2344)/FAX 03-3353-6597

第13回日本靴医学会
会長　井口　傑

第24回日本足の外科学会

募集要項，抄録用紙は日本足の外科学会雑誌(19巻2号)に綴じ込まれています。募集要項に則りご応募ください。日本足の外科学会に未加入の方は下記連絡先にご請求ください。

記

会　期：1999年6月18日(金)・19日(土)
会　場：コクヨホール（東京，品川駅港南口より徒歩1分)

演　題：以下のテーマを中心に，シンポジウム，主題，一般演題，ポスターを募集します。採否，発表の形式は会長にご一任ください。

1. 距腿・距骨下関節周辺骨折のサルベージ手術(関節固定術・人工関節を除く)
2. 外反母趾のサルベージ手術
3. 捻挫後の遺残性疼痛
4. 中足部(リスフラン関節周辺）の新鮮外傷
5. 足関節外側靱帯損傷の長期予後(5年以上，放置例も含む)
6. 足部，足関節の鏡視下手術
7. 画像診断の進歩
8. 新しい内固定材料，生体内材料

演題締め切り：1999年1月31日(日)(消印有効)

連絡先：〒160-8582　東京都新宿区信濃町35
慶應義塾大学医学部整形外科学教室内
第24回日本足の外科学会事務局
TEL 03-3353-1211(内2344)/FAX 03-3353-6597

第24回日本足の外科学会
会長　井口　傑

第19回日本骨形態計測学会

骨の形態学，形態計測に関連する演題を広く募集しています。日本骨形態計測学会会員の方には抄録用紙をお送りいたします。非会員で演題応募をご希望の方は下記の事務局までご連絡ください。

記

会　期：1999年6月25日(金)・26日(土)
会　場：北九州国際会議場(小倉駅北口より徒歩5分)
TEL 093-541-5931

プログラム

招待講演

How to Assess and Reducing the Risk of Osteoporotic Fractures in 1999
University of California Steven R. Cummings

シンポジウム

日常の骨粗鬆症診療における骨量測定の意義と役割

ミニシンポジウム

骨の三次元構造と強度

サテライトシンポジウム

副甲状腺ホルモンによる骨粗鬆症治療～基礎と臨床～

ランチョンセミナー

Bone Architecture and the Competence of Bone as Assessed by Micro-Computed Tomography
Harvard Medical School R. Mueller

演題締め切り：1999年3月31日(水)
事　務　局：〒807-8555　北九州市八幡西区医生ヶ丘1-1
産業医科大学整形外科学教室内
第19回日本骨形態計測学会事務局
TEL 093-691-7444/FAX 093-692-0184

第19回日本骨形態計測学会
会長　中村利孝
(産業医科大学整形外科学教室教授)

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