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目　次

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Motion Analysis of the Trunk during the Golf Swing

ゴルフスイングにおける体幹部動作解析

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●Key words
Motion Analysis : Lumbar Spine : Golf Swing
動作解析，腰椎，ゴルフスイング

●Abstract

We performed three-dimensional motion analysis to investigate the swing kinematics of the thoraco-lumbar spine and the pelvis during the golf swing. Seven top college golfers, all right-handed, were studied. Their average age was 18.9 years, and their mean number of years golfing was 7.3 years. The swings were recorded by two synchronized high-speed video cameras and analyzed using a three-dimensional motion analysis system. We defined three sticks for the analysis : stick-S, stick-R, and stick-P used as the shoulder, rib, and pelvic markers, respectively. Based on these three sticks, we then defined the axial rotational and lateral bending angles, and then calculated the angular velocities of the axial rotational angles. The golf swing was divided into five phases: take-away, early forward swing, late forward swing, early follow-through, and late follow-through. The swing during the forward swing through the follow-through was symmetric with respect to the neutral point where all the axial rotational angles were zero.

The upper trunk showed maximum axial rotation in the late forward swing while the lower trunk did so in the early forward swing. The axial angular velocity and lateral bending angle reached a maximum during the late forward swing through the early follow-through. The present study demonstrated that the golf swing involved rapid axial rotation and lateral bending of the trunk simultaneously during the late forward swing through the early follow-through. These findings suggest that the repetitive practice of this asymmetric trunk motion could be the cause of low back injuries in golfers.

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●要旨

先に我々が行なった男女283名のプロゴルフ選手のアンケート調査結果で、55%の選手に腰痛歴が認められ、これらは右側優位の局在を示した。さらに右側優位の腰痛は、特定のスイングフェイズとの相関を示した。今回、これら腰部症状の非対称性とゴルフスイングとの関連を検討するため、学生ゴルフ選手７名を対象として体幹部の三次元動作解析を行った。その結果、ゴルフスイングは脊柱の回旋と側屈の二次元的な複合運動であり、ダウンスイングからフォロースルーにおいては、回旋角速度が最大となると同時に強い右側屈が起こっていた。以上よりダウンスイングからフォロースルーにおける腰椎には、強い非対称性のストレスが加わってると考えられた。

INTRODUCTION

Golf requires less physical activity than other sports. This is the reason why many people of all ages can enjoy this sport. However, physical problems can occur because of the repetitive nature of the swing and the players' average age which tends to be relatively high. Among these problems, low back injury is very common. We reported an epidemiologic study of golf injuries in professional golfers at the 21 st. annual meeting of Japanese Orthopaedic Society for Sports Medicine[1]. According to the results, low back problems showed the highest incidence rate of 55% among professional golfers. The symptom was predominantly right-sided, and was aggravated during the forward swing through the follow through. We hypothesized that these low back injuries in highly skilled golfers were mainly due to the asymmetric motion of the swing itself, and to the repetitive practice of the swing.

Recently, many studies have reported the biomechanics of the golf swing. However, a major portion of the research was targeted at understanding and improving the golfer's performance[2,3,4]. To the best of our knowledge, no biomechanical study has focused on the relationship between the golf swing and its resulting ailments. The purpose of this study is to determine normal kinematics of the spine and the pelvis during the golf swing and to develop an understanding of the etiology of low back injuries in golfers.

MATERIALS AND METHODS

Seven top college golfers volunteered for this study. Their average age was 18.9 years, and their average golfing history was 7.3 years. The mean of their average score was 75.6 (range, 72 - 78), and their mean best round was 69.3 (range, 65 - 72). Their mean driving distance was 265 yards (range, 245 - 280). All subjects were right-handed and free of any orthopaedic disorders.

Twenty-one reflective markers were attached to each subject. Then, after proper warming-up exercises, they made three or four driver shots at an indoor driving range, and all swings were recorded by two synchronized high-speed video cameras (HSV- 500, nac Inc, Tokyo, Japan) at different angles at a rate of 250 frames per second (Fig. 1). The data were analyzed using a MOVIAS 3D system (nac Inc, Tokyo, Japan).

The trunk markers were placed on bony landmarks. The shoulder, rib, and pelvic markers were bilaterally placed on the lateral edges of the acromion, at the lowest parts of the rib cage on the mamillary line, and on the anterior superior iliac spines, respectively.

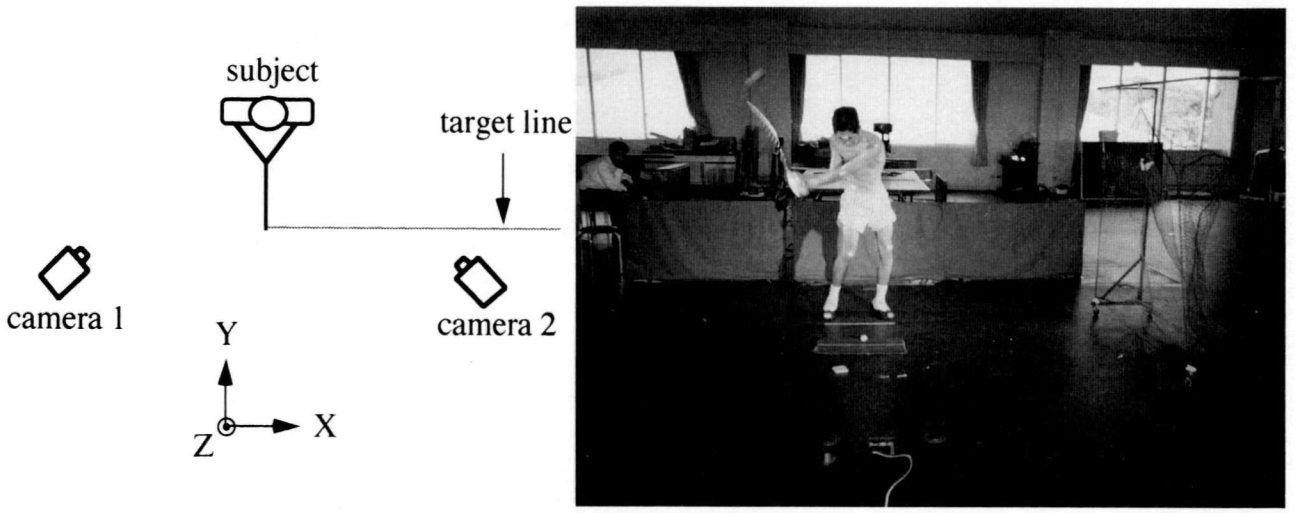


Figure 1. The examination set-up. Two synchronized video cameras from different directions were used to record the golf swing during actual ball hitting.

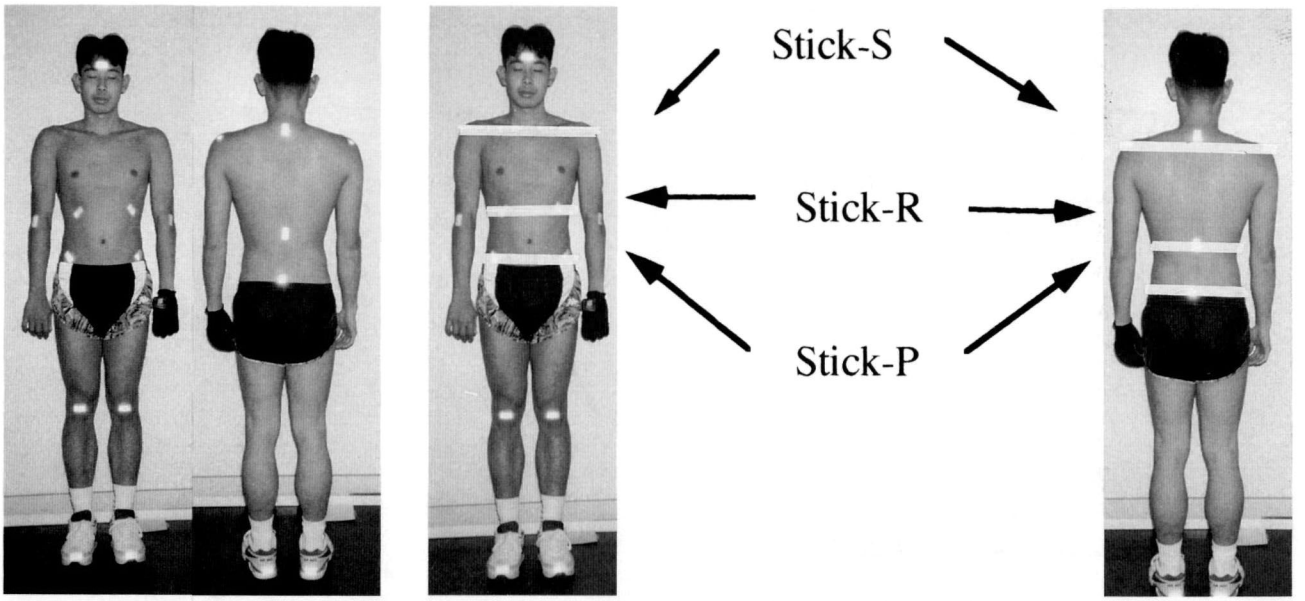


Figure 2. We applied 21 reflective markers (left) and defined 3 basic sticks (right). Stick-S was the line connecting the bilateral acromion markers, stick-R the lower end markers on the rib cage, and stick-P the anterior superior iliac spines.

Three markers were also placed on the spinal processes of the same levels. We defined three sticks; stick-S was a line between the two shoulder markers, stick-R between the two rib markers, and stick-P between the two pelvic markers (Fig. 2). Then we defined the axial rotational angle and the lateral bending angle, with the former being an angle between two sticks among the three projected on the X-Y plane: the S-P angle was the angle between stick-S and stick-P, the S-R angle between stick-S and stick-R, and the R-P angle between

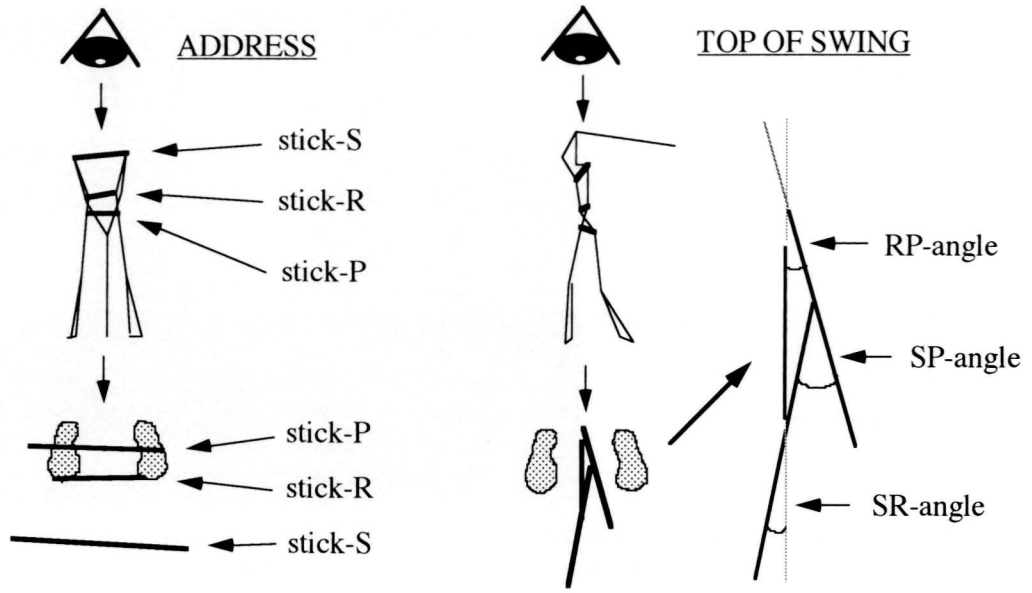


Figure 3. Each axial rotational angle was defined as the angle between two sticks projected on the X-Y plane, as shown in Fig. 1.

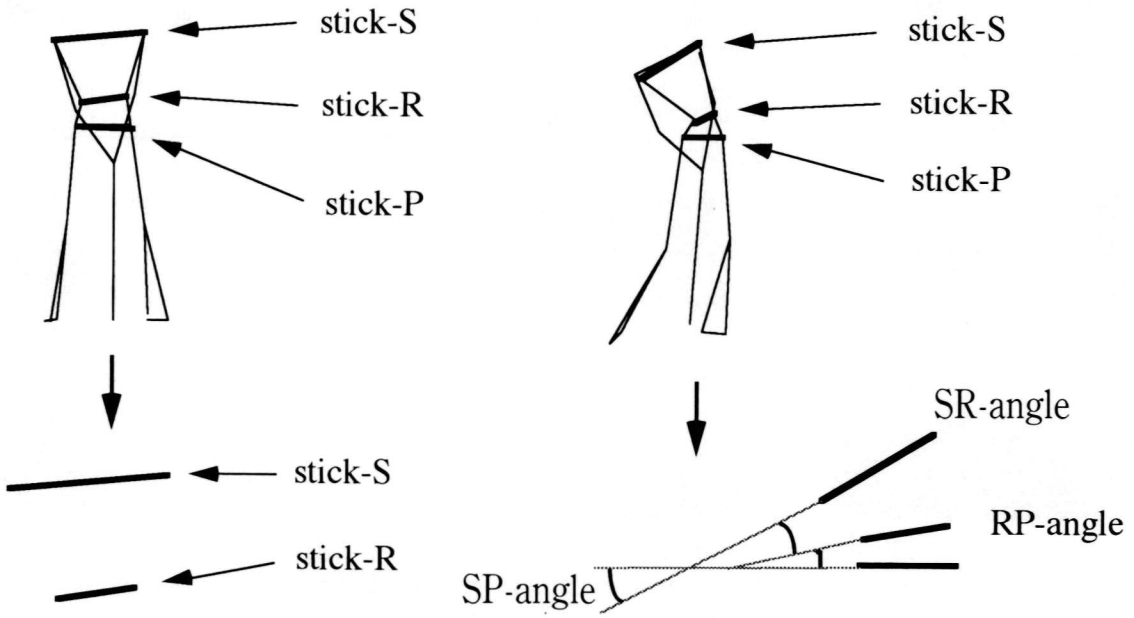


Figure 4. Each lateral bending angle was defined as the angle between two sticks projected on the moving plane parallel to the chest wall.

stick-R and stick-P (Fig. 3). The lateral bending angle was between two sticks among the three projected on a moving plane parallel to the chest wall (Fig. 4). The axial rotational angular velocities were also calculated.

Based on the preliminary results, we defined seven representative events during the golf swing: address; top of swing; mid-forward

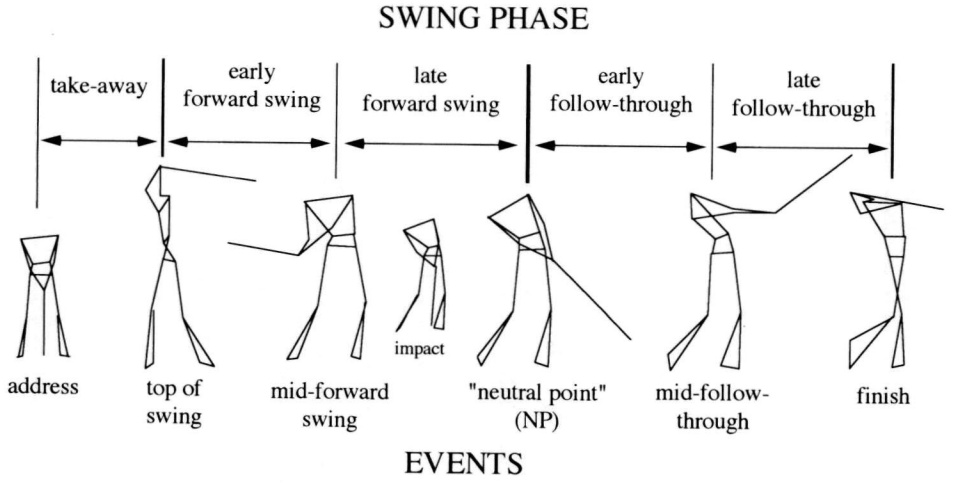


Figure 5. We defined 7 evnets (bottom). The neutral point (NP) occurred at (8- 17)/250 second after the impact. The golf swing during the top of swing to the finish was symmetric with respect to NP. According to these events, the swing was divided into 5 phases (top).

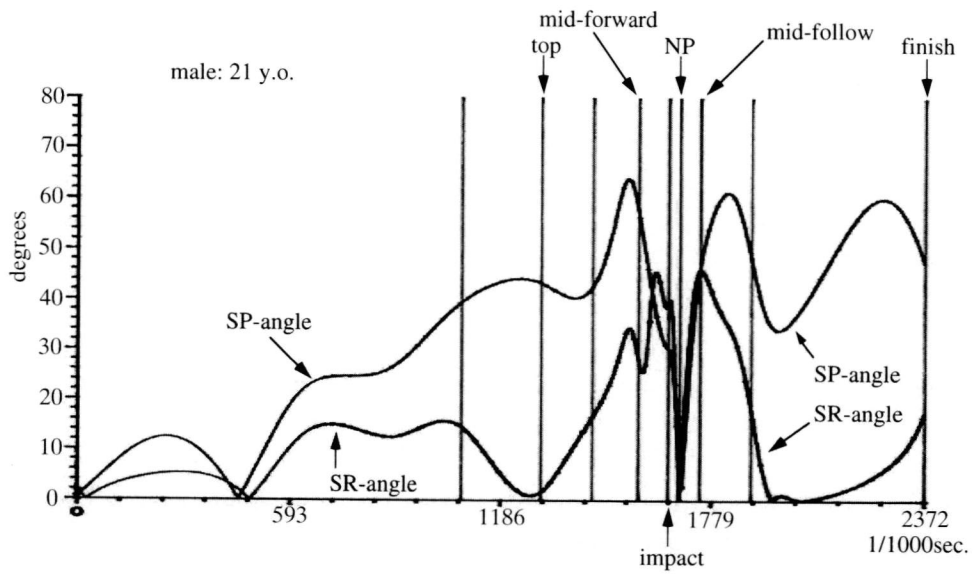


Figure 6. Serial changes in the absolute S-P and S-R angles, in an illustrative case. They were almost symmetric with respect to the event of the NP. The peaks of the S-R angle were during the late forward-swing and early follow-through.

swing where the pelvis was fixed during forward swing; impact; neutral point (NP) where all the axial rotational angles were zero; mid-follow-through where stick S was at a right angle; and finish. The NP occurred during 8 to 17 frames (for 8 - 17/250 second) after the impact. According to these events we defined five swing phases: take-away which was from the address to the top of swing; early forward swing which was from the top of swing to the mid-forward swing; late forward swing which was from the mid-forward swing to the NP; early follow-through which was from the NP to the mid-follow-through; the late follow-

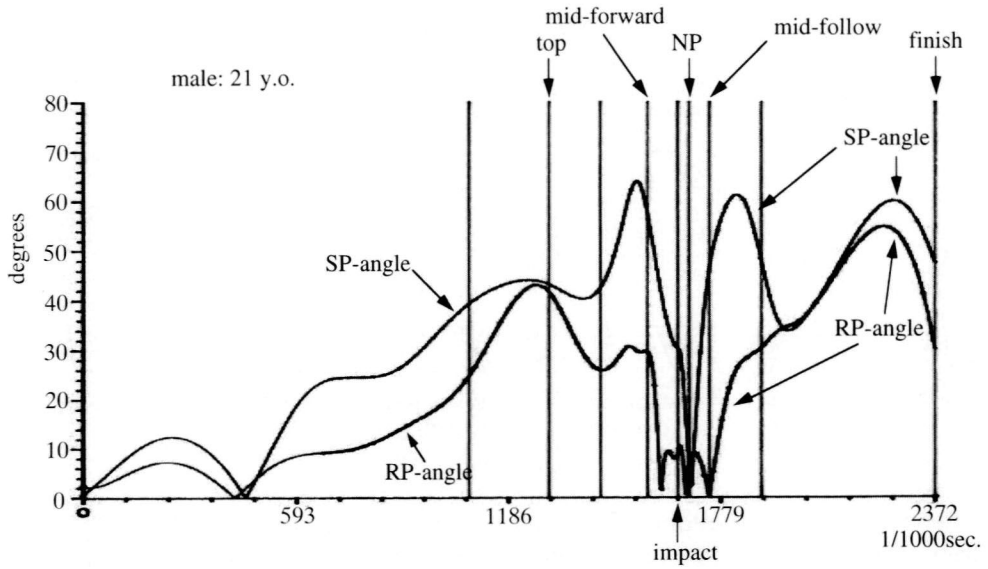


Figure 7. Serial changes in the absolute S-P and R-P angles, in an illustrative case. They were almost symmetric with respect to the evnet of the NP. The peaks of the R-P and were during the early forward-swing and the late follow-through.

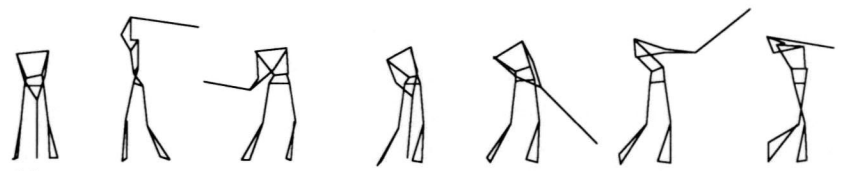
through which was from the mid-follow-through to finish (Fig. 5).

RESULTS

Data from one representative case are shown in Fig. 6 and Fig. 7 . For serial changes in the S-P and S-R angles in axial rotation, the patterns were almost symmetric with respect to the NP. The absolute value of the S-R angle showed two peaks at the events immediately before and after the NP. The angular velocity of the S-R angle reached a maximum near the NP (Fig. 6). Serial changes in the S-P and R-P angles are shown in Fig. 7 . The absolute value of the R-P angle showed two peaks, one in the early forward swing and the other in the late follow-through. while it remained low during the late forward swing to the early follow-through, However, the angular velocity showed two peaks, in the late forward swing and in the early follow-through. Similar patterns were observed in the other six cases. The S-P, S-R, and R-P angles in lateral bending reached a maximum during the late forward swing to the early follow-through. These patterns were also the same in the other six cases.

The mean values of the axial rotational angles, angular velocities and lateral bending angles are shown in Table 1 . In axial rotation, the mean S-P angle was 50 degrees, which was nearly maximum at the event of the mid-forward swing. On the other hand, the S-R angle reached a maximum during the late forward swing while the R-P angle was maximum in the early forward swing. The angular velocity of the R-P angle reached a maximum during the late forward swing to the early follow-through. In lateral bending, all three angles showed similar patterns, a maximum during the late forward swing to the early follow-through. The maximum lateral bending angle of the S-P was 30 degrees, while the S-R

Table 1. Average axial rotational angles, angular velocities, and lateral bending angles (n=7).



EVENTS		address	top	mid-forward	impact	NP	mid-follow	finish
axial rotational angles (degrees)	SP	-3	44	50	30	0	-22	-29
	SR	-3	24	38	28	0	-18	-8
	RP	1	20	13	4	0	-4	-2
angular velocities of axial rot. angles (degrees/sec.)	RP		74	764	(50)	363	146	60
lateral bending angles (degrees)	SP	11	-12	3	23	30	30	-4
	SR	6	0	-5	9	20	20	0
	RP	5	-12	8	14	11	10	-2

angle was 20 degrees and the R-P angle were 10 to 14 degrees.

DISCUSSION

McCarroll and Gioe [5] divided the swing phase into three segments: take-away, impact, and follow-through. While Jobe and colleagues [6,7] divided the swing phase into five segments: take-away, forward swing, acceleration, early follow-through, and late follow-through. Their classification was almost symmetric with respect to the impact while ours was symmetric with respect to the NP. In many reports, the golf swing from the top of the swing to the finish was always divided at the impact. However, from our biomechanical analysis, we believe that the swing should be divided at the neutral point which occurs at 8 - 17/250 second after the impact because it is the real "mid-point" of the swing from the top to the finish. In highly skilled golfers, the kinematics of the trunk are almost uniform even though many variations can be seen in the motion of the upper extremities. Therefore, we believe that our classification, based on the swing kinematics of the trunk, is suitable for a biomechanical description of the golf swing.

The trunk motion during the swing is a combination of axial rotation and lateral bending. To simplify the kinematics of the golf swing, we defined and applied three sticks for the analysis. In the present study, the S-P angle was the summation of the S-R and R-P angles. The S-P angle represented the movement of the trunk and the shoulders which ultimately amounted to 50 degrees at the event of the mid-forward swing. The S-R angle, which reached a maximum during the late forward swing, represented the movements of both the scapulo-thoracic articulation and the thoracic spine, while the R-P angle, reaching a maximum during the early forward swing, represented the movements of both the lower thoracic spine and the lumbo- sacral spine.

At the beginning of the forward swing, the pelvis began to rotate to the left prior to the upper trunk movement, which was fixed at the

mid-forward swing. During the late forward swing to the early follow-through, rapid release of rotation and rewinding of the upper trunk and the scapulo-thoracic articulation occurred together with maximum lateral bending. These observations indicated that both quick rotation and maximum lateral bending of the lumbar spine occurred simultaneously during the late forward swing to the early follow-through.

Studies on the kinetics during the golf swing have been rare. Hosea et al[3]. studied the biomechanical forces affecting the lumbar spine in professional golfers. They concluded that the golf swing produced a complex loading pattern involving large shear, lateral bending, compression, and axial torsional loads with rapid changes in the directions of these forces. They also stated that peak load occurred during the forward swing and acceleration phase of the golf swing. During the forward swing to the follow-through, a greater load on the lumbar spine was also observed.

In conclusion, the golf swing involved significant asymmetric motions of the trunk, with the quick axial rotation of the spine occurring around the point of maximum lateral bending. These observations suggest that both high loads to the lumbar spine and asymmetric lumbar motions could be the cause of low back injuries during the golf swing. Further, the repetitive practice of such asymmetric motion contributes to the cause of low back injuries in golfers. We believe this information represents an important first step in developing a better understanding of the etiology of low back injuries in golf.

Acknowledgment

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Resumption of Sports Activities for Patients in their Growth Period with Spondylolysis or Spondylolisthesis

成長期脊椎分離・すべり症のスポーツ活動復帰状況について

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●Key words
Spondylolysis and spondylolisthesis : Sports activities : Risk factor of bone union
脊椎分離症と脊椎分離すべり症，スポーツ活動，骨癒合の危険因子

●Abstract

Separation in the vertebral arch is known to be related to the sports activities of the patients, in their growth period.[2,3]

Here we have evaluated 10 risk factors which may affect bone union at spondylolysis in individual 116 cases and estimated the possibility of occurrence of bone union.

We reviewed the treatment and the resumption of sports activities for 78 patients in there growth period with spondylolysis and spondylolisthesis. Abnormal spinal curvature was the risk factor with highest correlation to non-union.

A total of 5.5 risk factors on average were related to separation in the vertebral arch. All risk factors concerned the patients aged 13.5 to 17 years. Bone union could be expected to occur at the incipient or progressive stage with appropriate treatment.

Resumption of sports was permitted at 6 months after treatment at the incipient or progressive stage. For patients at the terminal stage, resumption of sports was permitted only after the disappearance of symptoms.

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●要旨
椎弓分離の発生には発育期におけるスポーツ活動と深い関連性がある。今回は分離部の骨癒合に対するRisk factorとして10項目を設けて116症例に対応し、骨癒合の予測に加え、成長期脊椎分離・すべり症78例のスポーツ活動復帰状況等について検討を加えた。Risk factorの陽性率は脊柱彎曲異常が76.6%と最も高く、次いでスポーツ活動74.2%、年齢69.6%などで、平均5.5項目であった。初診時年齢13.5～17歳までは全てのRisk factorが関与していた。初期・進行期例では適切な治療を行えば骨癒合が期待でき、スポーツ活動復帰時期は初期・進行期例では少なくても6ヵ月後とし、終末期例では愁訴消失時とした。

MATERIALS & METHOD

A total of 78 patients during their formative growth period were engaging in sports activities. These consisted of 53 patients with spondylolysis and 25 with spondylolisthesis.

Of these, 33 patients (Group S) were injured during the sports activities. Their overall mean age at the time of occurrence of symptoms was 14.1 years (range 5～19 years).

The overall mean age at initial examination was 15.0 years and at the time of this investigation was 16.8 years old.

All 78 patients complained of low back pain (100%). 11 patients (14.1%) complained also of buttocks pain and a further 9 patients (11.5%) complained of thigh pain. Only very few complained of lower-leg pain or back pain.

Spondylolysis occurred at L5 in 61 patients, at L4 in 4 patients, at L6 in 2 patients and at the multiple vertebral levels in 11 patients. Overall 94.9% of spondylolysis occurred at the lowest lumbar vertebra. Spina bifida was observed in 43 patients (55.1%).

The following 6 points on the X-ray films were measured ; - 1) spinal curvature (Yamamoto), 2) thoracic kyphosis & lumbar lordosis, 3) percentage of slipping (Marique-Taillard), 4) movement of vertebra (Okada), 5) lumbosacral angle and 6) sacral inclination (Fig. 1).

A check-list of 10 risk factors against bone

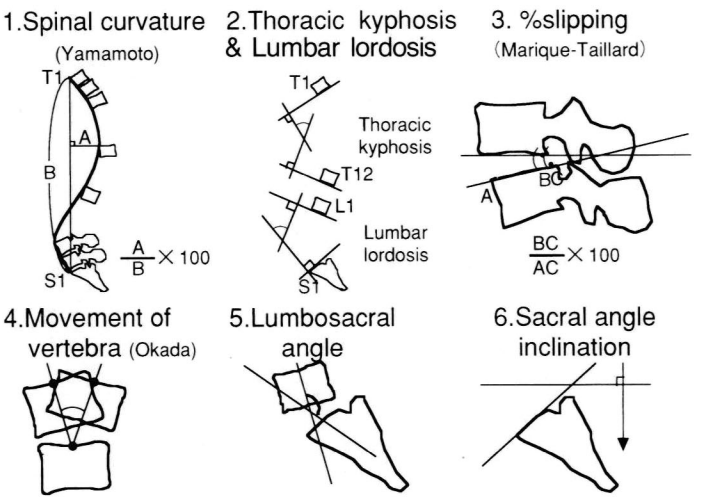

Fig.1 Methods of measurement

union was compiled for 116 patients in there growth period with spondylolysis and spondylolisthesis.

Three of these risk factors were due to external cause ;- 1) sports activities, 2) age over 18 y.o. or under 11 y.o. (congenital factor), and 3) family incidence. The other 7 risk factors were morphological and determined by X-ray; - 1) the morphology of the separation site (advanced stage and terminal stage: by Ikata), 2) abnormal spinal curvature, 3) spina bifida, 4) movement of vertebra; over 10° (mean+over 1 SD), 5) inclination of facet; over 110° (mean+ over 1 SD), or lumbosacral angle ; over 155° (mean + over 1 SD), 6) lumbar index; under 82% (mean−over 1 SD) or sacral angle inclination ; over 50° (mean+over 1 SD), and 7) multiple lumbar spondylolysis.

RESULTS

The 10 risk factors were reviewed over all 116 patients with spondylolysis or spondylolisthesis in their growth period. An abnormal spinal curvature was the risk factor of highest (76.6%) incidence, followed by sports activities (74.2%), and age (69.6%). Both family incidence and multiple lumbar spondylolysis were risk factors of low incidence.

The average age at the time of diagnosis was 14.2 years for spina bifida, 14.5 years for inclination of facet or lumbosacral angle, 14.5 years for family incidence, 14.6 years for movement of vertebra, 14.6 years for lumbar index or sacral angle inclination, 14.9 years for multiple lumbar spondylosis, 15.0 years for abnormal spinal curvature, 15.0 years for sports activities, and 15.9 years for the morphology of separation. The age range at diagnosis over all 10 risk factors was 13.5 to 17 years (mean-over 1 SD) (Table 1).

The main risk factors for those aged under 11 years were a congenital factor in 6 cases. These 6 cases had an averaged of 6.5±1.4 factors. They can be compared with those aged over 18 years who had an averaged of 6.1±1.9 factors, and with those aged 12 to 14 years who averaged 4.9±1.8 factors. Those aged 15 to 17 years had

Table.1 Risk Factor Positive Rate.

Risk Factor	frequency	cases	mean age
1.Abnormal spinal curvature	76.6%	72 / 94	15.0±3.0
2.Sports activities	74.2	78 /105	15.0±2.6
3.Age	69.6	80 /115	15.8±2.9
4.Inclination facet or Lumbo-sacral angle	62.0	62 /100	14.5±3.0
5.Spina bifida	59.6	65 /109	14.2±2.8
6.Morphology of the separation site	59.0	59 /100	15.9±2.4
7.Movement of vertebra	54.9	56 /102	14.6±2.7
8.Lumbar index or Sacral angle inclination	40.1	45 /112	14.6±2.9
9.Incidence of family	33.6	39 /116	14.5±2.6
10.Multiple vertebral separation	14.1	16 /113	14.9±2.5

(Spondylolysis and spondylolisthesis during the growth period : 116 cases)

5.5±2.0 factors. The overall average was 5.5± 1.9 factors.

The presence or absence of pain in relation to the risk factors was investigated at the time of examination. In those who had pain, the average number of risk factors was 5.9±1.8 : involving those with spondylolysis associated with 5.2±1.8 risk factors and those with spondylolisthesis associated with 7.1±0.9 risk factors. In those who had no pain, the average number of risk factors was 5.0±2.1 : those with spondylolysis associated with 4.2±1.7 risk factors and those with spondylolisthesis associated with 6.8±1.7 risk factors. Overall those who had pain were associated with more risk factors.

In those who had pain the symptomatic group, most (94.8%) had abnormal spinal curvature. These were further divided according to the form of spinal curvature: 16 had increased lumbar lordosis (41%), 16 increased thoracic kyphosis (41%), and 5 increased lordosis and kyphosis (12.8%). The other 2 (5.1%) had normal spinal curvature .

In those who had no pain (the asymptomatic groups), 17 (60.7%) patients had normal spinal curvature and 11 (39.3%) patients had abnormal spinal curvature. The incidence of pain with spondylolytic spondylolisthesis was accordingly associated with lower lumbar load by abnormal spinal curvature (Table 2).

The patients began sports activity (volleyball, basketball, swimming, soccer, baseball, etc.) as extracurricular activity at a mean age of 12.0 years, had been engaged in such sports activity for a mean of 4.0 years, and developed symptoms at a mean age of 14.1 years. Their mean age at the initial examination was 15.0 years. There was no statistical difference in these ages among the different types of sports.

Thirty-three patients in Group S, who was attacked at sports activity (involving 20 males and 13 females) began sports activity at a mean age of 11.8 years, and had been engaged in the activity for a mean of 3.7 years. They were accustomed to engage in intense sports activities for a mean of 4.9 days a week and for a mean of 3.4 hours a day. They started experiencing pain about 3 years after they began sports activities. Their average age at that time was 14.4±2.2 years, and their average age at the initial examination was 15.1±2.4 years.

Concerning the stage of spondylolysis at the time of initial examination in Group S, 9 were

Table.2 Spinal Curvature of the Symptomatic Group and Asymptomatic Group

	Symptomatic Groups		Asymptomatic Groups		Total	
Lordosis increased type	16cases	41.0%	5cases	17.9%	21cases	31.3%
Kyphosis increased type	16	41.0	4	14.3	20	29.9
Lordosis and kyphosis increased type	5	12.8	2	7.1	7	10.4
Normal group	2	5.1	17	60.7	19	28.4
Total	39cases		28cases		67cases	

in the early stage at a mean age of 12.9 years and with an average of 5.6±1.4 risk factors, and 17 were in the advanced stage at a mean age of 15.6 years and with an average of 5.6±2.1 risk factors, and the other 7 were in the terminal stage at a mean age of 16.7 years and with an average of 6.0±2.6 risk factors.

In Group S, 2 patients were treated with plaster cast fixation, rigid orthosis and soft corset bracing, 5 with soft corset bracing for a mean period of 6.5 months, and the remaining 26 with other treatment. The complaints were alleviated in all those who received appliance therapy, and bone union was confirmed in a total of 9 patients, involving 6 of the 7 patients treated in the early stage and 3 of the 8 patients in the advanced stage.

In Group S, nine patients abstained from both extracurricular activities and gymnastics classes, while a further 9 abstained only from extracurricular activities. 4 patients continued or abstained from sports activities and the other 11 patients continued both extracurricular activities and gymnastics classes.

The mean duration of abstention was 10.3 months in those who abstained from both extracurricular activities and gymnastics classes and 6.2 months in those who abstained only from extracurricular activities. The mean period of abstention from gymnastics classes was 7.3 months.

No symptoms were observed at the time of resumption of extracurricular activities. At the time of the follow-up evaluation, bone union was observed in 14 (93%) of 15 patients in the early or advanced stage who abstained from all sports in Group S.

Although mild back pain persisted in 6 (40%) of those 15, it caused no problem in all sports activities. In those who continued sports activities, however, bone union was observed in only 2 patients at the time of evaluation, and nonunion was observed in 9 patients (82%) who had symptoms such as low back pain.

In this study, 15 of the 19 patients in the early or advanced stage abstained from sports, bone union was achieved in 14 (93%) and 8 (57%) could resume sports activities without complaint. Of the remaining 4 patients who resumed sports activities, 2 patients showed bone union and

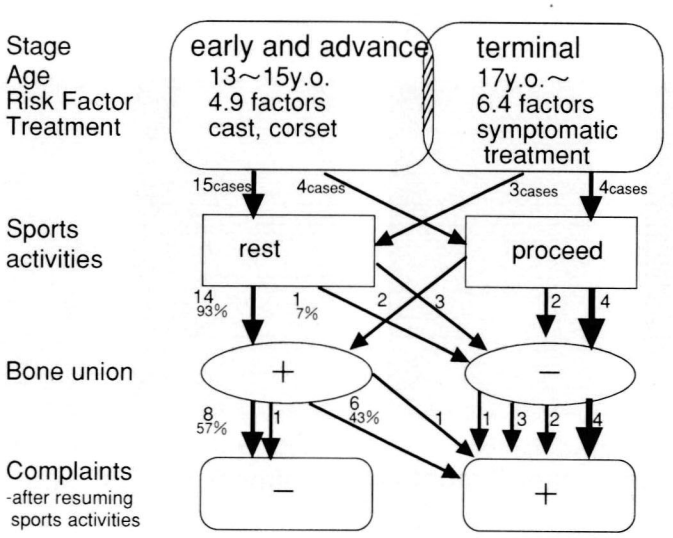

Fig.2 Couse of treatment on classification of the morphology.

2 patients showed vertebral separation and had pain during sports activities. Three patients in the terminal stage abstained from sports, but bone union was not observed, and they occasionally complained of mild low back pain (Fig. 2).

The 21 patients who achieved bone union were treated with soft corset bracing for a mean of 6.0±3.4 months and abstention from sports activities for a mean of 6.0 ± 3.9 months in addition to abstention from gymnastics classes for 4.0 ± 6.8 months.

They had an average of 4.9 risk factors of 4.9.

Most of the patients with bone nonunion were treated with symptomatic treatment. These patients continued extracurricular activities but abstained from gymnastics classes for a mean of 2.3 ± 3.3 months. They had an average of 6.4 risk factors, significantly more from those with bone union.

Although the 14 patients in Group S were treated without corset bracing, only 5 patients (35.7%) showed bone union.

Case Report 1 : A 13-year-old male practiced Japanese fencing for 4 days each week from the age of 10 years and developed low back pain during practice. A diagnosis of advanced spondylolysis was made, and cast fixation was done. The site of spondylolysis became slightly obscured after 6 months. At 9 months after fixation he started swimming. Bone union was clear at 1 year after fixation. At a follow-up examination at the age of 16 years, bone union was confirmed radiographically and the patient had resumed sports with no symptoms of pain (Fig.3).

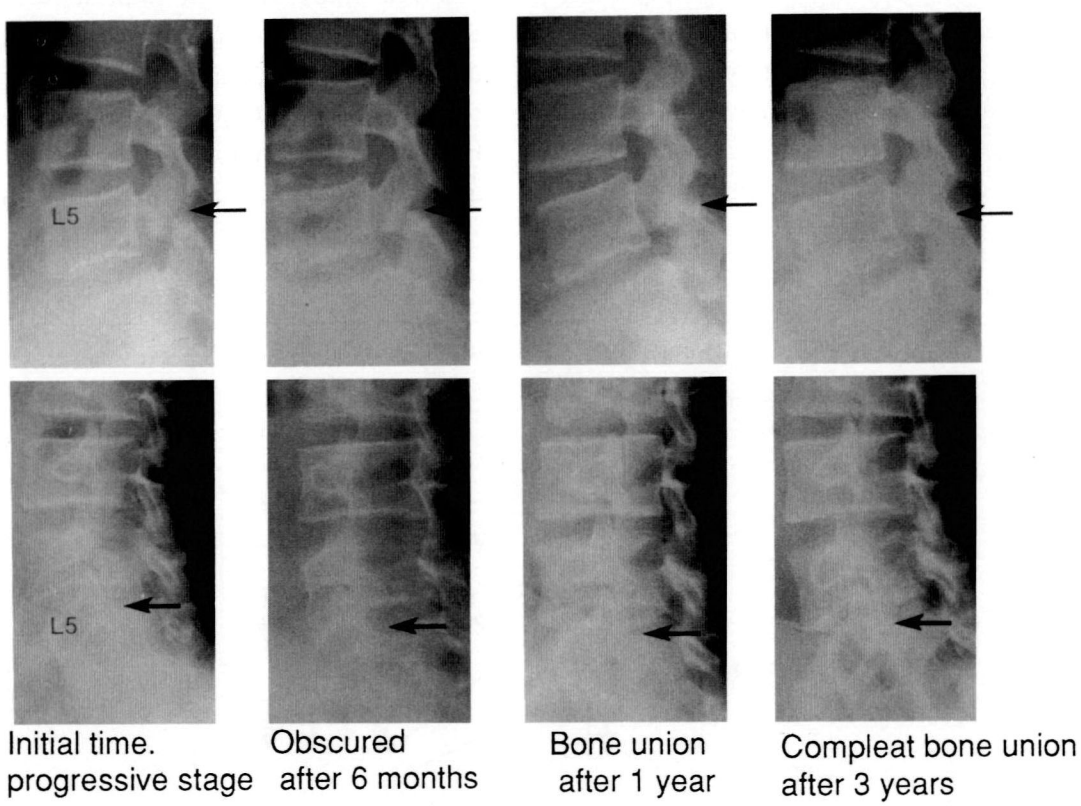

Fig.3 13-year-old male. Bone union.

Case Report 2 : A 7-year-old female was one of the 4 (5.1%) patients with a suspected congenital factor. The disease was already in the advanced stage at the initial examination, and a slide of 25.2% was observed. The symptoms were alleviated by cast fixation, but bone nonunion was observed. The patient resumed sports after the physician explained her condition. One year later, the disease showed a terminal profile, and the slide had advanced to 34.4% (Fig.4).

Discussion

Akimoto[1] reported, as the radiographical findings of early spondylolysis was detected, it was easy to get bone union by abstained from sports activities,and cast fixation.

Ikata[4] reported that bone union was achieved by conservative therapy in cases of early spondylolysis and that resumption of sports was possible even in cases in which bone union could not be obtained. Kondoh[5] reported that in split-type spondylolysis, attempts were made to establish bone union by muscle training and corset bracing. For pseudoarthritis type cases, in order to alleviate symptoms without restricting sports activities, soft corset bracing was used. Those who were able to obtain bone union were split-type spondylolysis cases, and 14 of 17 cases had no subjective symptoms.

The results of our study were similar. Our patients in whom bone union was observed

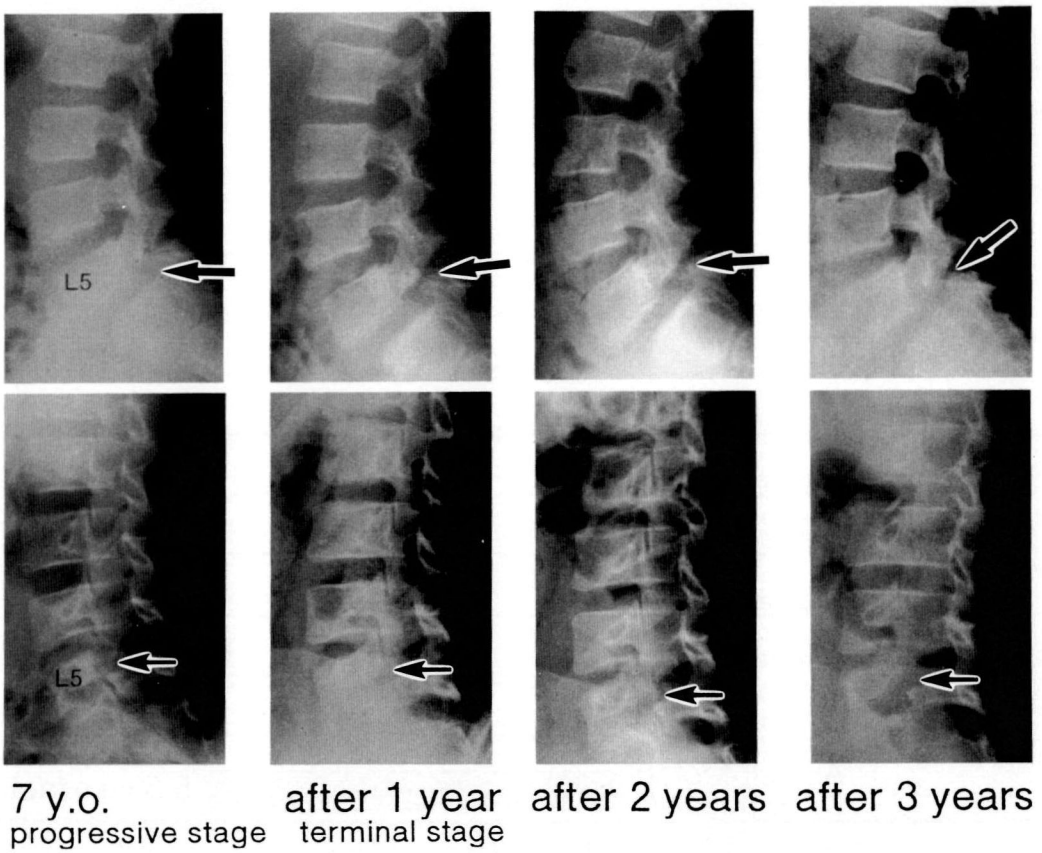

Fig.4 7-year-old female. Congenital factors were suspected.

were treated by application of a soft corset for a mean period of 6 months and abstained from gymnastics classes as well as extracurricular activities for 4 months. They had shown a total of 4.9 risk factors , significantly less than those in whom no bone union was observed.

Hase[6] reported that risk factors for spondylolysis including an external cause such as sports activities and internal cause such as spina bifida, aplastic lamina, lumbar index, increased lordosis, etc., were radiographically characterized.

Murase[7] reported that on X-ray examination, spondylolysis was found to be closely correlated with trapezoid deformity at L5 and increased lumbar lordosis.

Sato[8] reported that the occurrence of spondylolysis could be found radiographically before the onset of symptoms. Those factors relating to the occurrence of spondylolysis (large lumbosacral angle, horizontality of intervertebral facet angle, instability of intervertebral disk) should be closely observed.

All risk factors were positive in patients ages between 13.5 and 17 at the initial examination, and appropriate treatment and guidance was considered to be needed depending on the individual factors.

From these findings, we reached the following conclusion about the treatment for young patients with spondylolysis or spondylolisthesis. First, the condition of the patients, including the possibility of bone union, must be explained sufficiently to the patients themselves, their families, and coaches. Resumption of sports is possible in early and advanced cases by load reduction therapy for low back pain, including application of appliances depending on the individual risk factors, and in terminal cases after the disappearance of symptoms by symptomatic treatments alone.

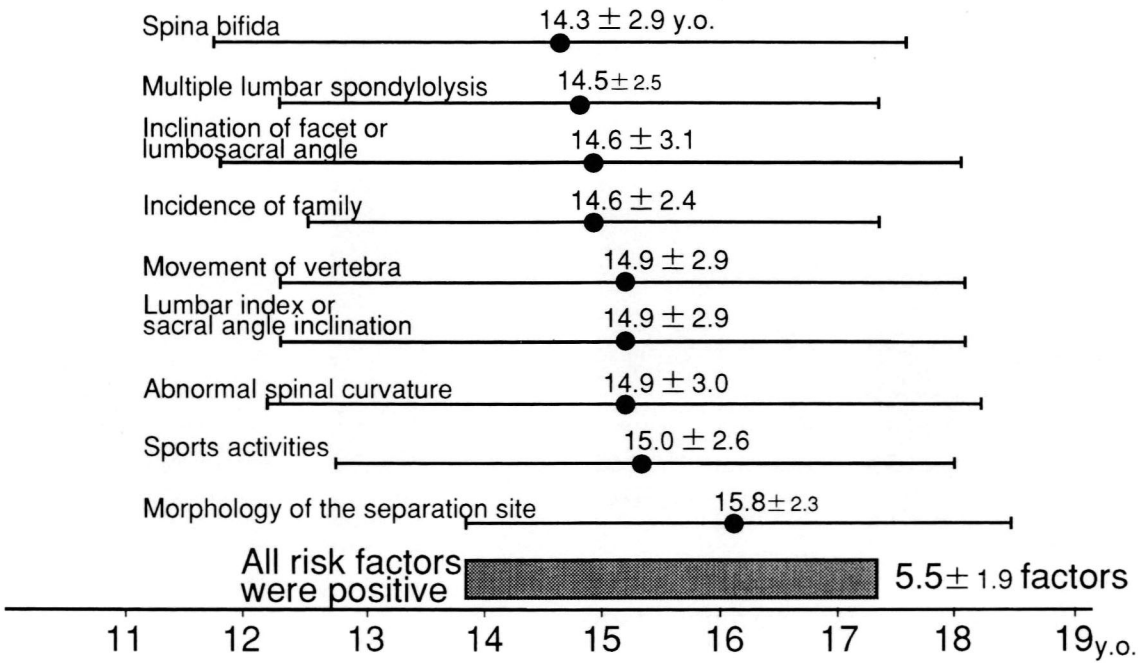

Fig.5 Risk factor concerning with the age at the initial time.

Conclusion

1. We studied the treatments and outcomes, including the resumption of sports, in 78 patients who had spondylolysis or spondylolisthesis during their growth years.
2. A mean of 5.5 risk factors were present in patients who achieved bone union of the separated vertebral arch.
3. All risk factors were present in patients who were 13.5-17 years of age at the initial examination.
4. Bone union was possible with appropriate treatment either early or advanced cases.

   Resumption of sports was permitted after at least 6 months in early or advanced cases, or after the disappearance of symptoms in terminal cases (Fig.5).

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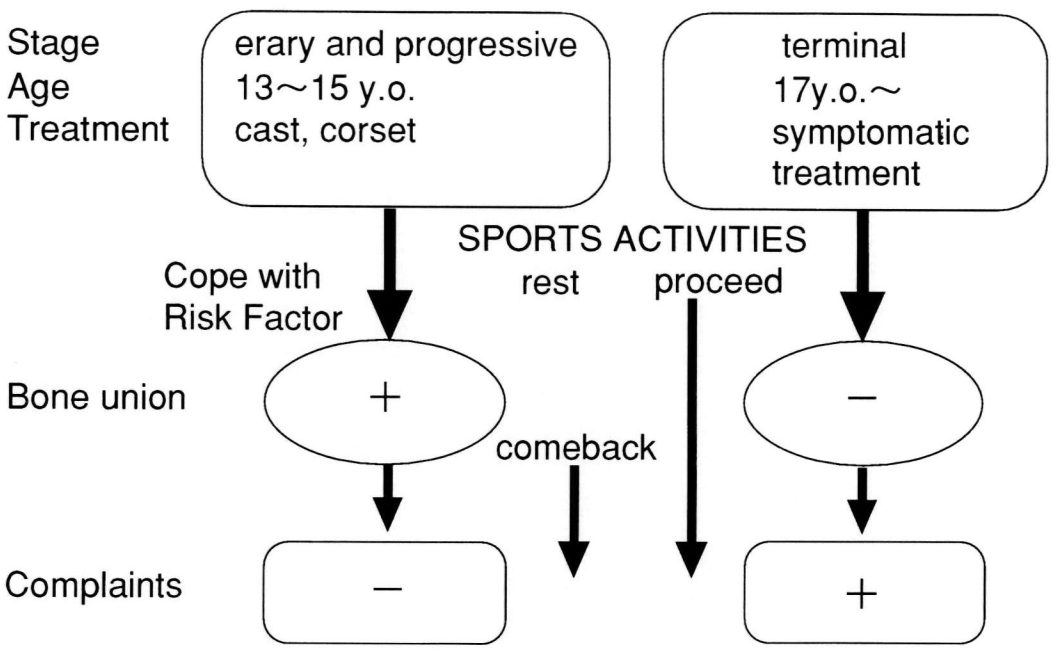

Fig.6 Method of treatment.

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Effect of Plyometric Jump Training for Female Volleyball Players

実業団女子バレーボール選手における プライオメトリック・ジャンプ・トレーニングの効果

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●Key words
Plyometric : Eccentric muscle contraction : Volleyball
プライオメトリック，伸長性筋収縮，バレーボール

●Abstract

To investigate the effect of plyometric drop-jump training on the quadriceps femoris muscle, twelve female volleyball players were divided into a plyometric training group (6 players) and a squat training group (6 players). Plyometric training consisted of 15 jumps/min/set, while Squat training was 60 bendings/min/set. Both types of training were performed over 10 days (at 5 sets/day) for a period of 4 weeks. Concentric and eccentric isokinetic testing was undertaken before and after the 4-week training.

The eccentric peak torque (EPT) was improved in both the Plyometric group and the Squat group. The Plyometric group had a significantly higher improvement ratio in the middle (120 deg/sec., $p<0.05$) and high (180 deg/sec., $p<0.1$) angular velocity in EPT, than the Squat group. The peak interval distance (PID) was shortened after training in the Plyometric group. The improvement in PID was significantly higher in the Plyometric group than in the Squat group in the middle ($p<0.1$) and high ($p<0.01$) angular velocity.

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●要旨

大腿四頭筋におけるプライオメトリック・ドロップ・ジャンプ・トレーニングの効果を知るために、12名の女子バレーボール選手をプライオメトリック・トレーニング・グループ（6選手）とスクアット・グループ（6選手）の2群に分け，比較検討した。スクアット・トレーニングが1セット－1分間に60屈伸であるのに対して、プライオメトリック・トレーニングは1セット－1分間に15回のジャンプを行わせた。両トレーニングは4週間の期間内に合計10日間（1日5セット）行った。短縮性および伸長性アイソカイネティック筋力測定をトレーニングの前後に行った。

伸長性ピーク・トルクはプライオメトリックおよびスクアット・グループの双方で改善された。プライオメトリック・グループはスクアット・グループに比べ，中速（120°/秒，$p < 0.05$）および高速（180°/秒，$p < 0.1$）の角速度における伸長性ピーク・トルクの改善率が有意に高かった。ピーク間距離はトレーニング後、プライオメトリック・グループのすべての角速度において短縮した。プライオメトリック・グループのピーク間距離の改善率は、中速（$p < 0.1$），高速（$p < 0.01$）の角速度で，スクアット・グループに比べ有意に高かった。

All competitive volleyball players are eager to acquire the skills of higher jumps and quicker movements. Several papers have been published on plyometric training, which is thought to improve explosive muscle activities.

The purpose of this study was to investigate the effect of plyometric drop-jump training on the quadriceps femoris muscle of female volleyball players.

Materials and Methods

Twelve female volleyball players with an average age of 20 years were investigated. They belonged to a company volleyball team which competed at the national level in Japan.

They were divided into two groups: a Plyometric group in which 6 players did plyometric drop-jump training, and a Squat group in which the other 6 players did squat training (Table 1).

Plyometric training consisted of jumping down from a 40 cm height, with a 90-degree flexion of the knee on landing, followed by a continuous maximum jump-up (Fig.1). In plyometric training, the quadriceps femoris

Table 1 Training groups

1. PLYOMETRIC group :
6 players with plyometric training
2. SQUAT group :
6 players with squat training

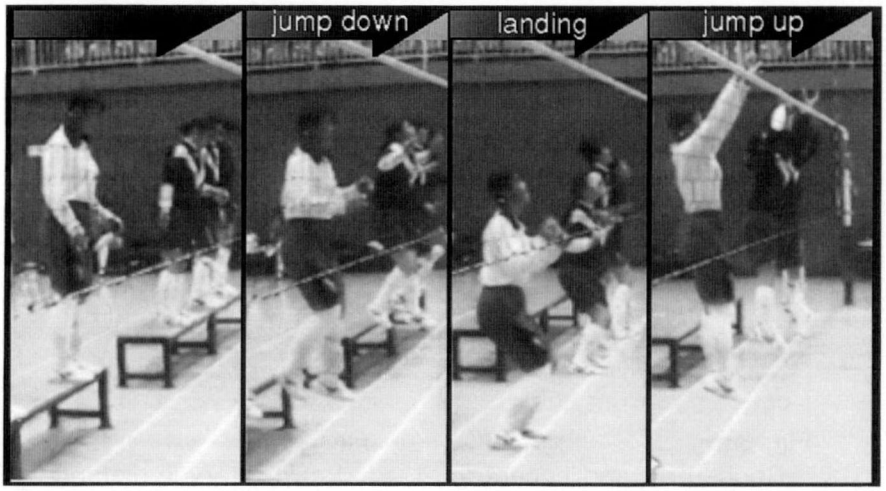


Fig.1 Plyometric drop-jump training.
Jump down from a 40 cm height, and continuous maximum jump up.

Fig.2 Squat training.
Half-squat exercise with fast mild knee bending.

muscles underwent eccentric contraction on landing, and concentric contraction on the subsequent jump-up. In the squat training, each player performed the "half squat exercise" with fast mild bending of the knee. This was performed 60 times in 1 minute as 1 set (Fig. 2).

Each Plyometric training set consisted of 15 repeated jumps in one minute, compared with 60 knee bendings/minute in the Squat training. Players in both the Plyometric group and the Squat group performed 5 sets a day, with a 1-minute break after each set, after their regular routine practice. Each type of training was performed twice or 3 times a week. In total, the training was carried out 10 times over a 4-week period.

Concentric and eccentric isokinetic testing was performed on the quadriceps femoris muscles using a Cybex machine, and the muscle torque and contraction speed were measured before and after the 4-week muscle training (Fig.3-a). The items measured were 1. the peak torque of the concentric and eccentric contraction of the quadriceps femoris as a peak torque: weight ratio, and 2. the peak interval distance. The peak interval distance (PID) was established as

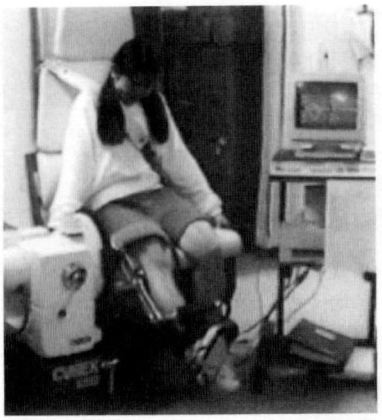


Fig. 3-a
Concentric and eccentric isokinetic testing.
(on 60, 120, 180°/sec of angular velocity, Cybex 6000)

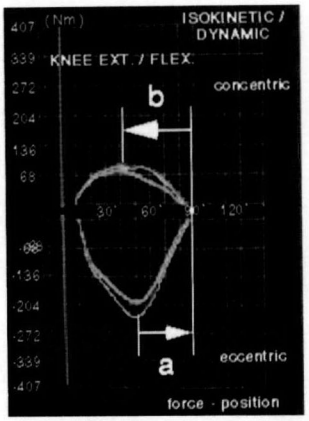


Fig. 3-b
Peak interval distance (PID): time from peak eccentric to peak concentric contraction =a+b(sec.).

Table 2. Methods of Comparison between the Plyometric Group and the Squat Group.

1) Improvement ratio (%) of peak torque

= Post- / Pre-training peak torque (Nm) x 100

2) Improvement ratio (%) of peak interval distance

= (Pre - Post) / Pre-training peak interval distance (sec.) x 100

the time from the peak eccentric contraction to the peak concentric contraction (Fig.3-b). These were measured at 60, 120, and at 180 degrees/second angular velocity.

Both groups were compared on their improvement ratios. The improvement in peak torque was the percentage of post-training peak torque to pre-training peak torque, and the improvement in PID was the percentage of shortening of the pre- to post-PID (Table 2).

Results

Pre- and post-training peak torque : weight ratio of the concentric contraction of the quadriceps femoris is shown in Figure 4-a. The concentric peak torque (CPT) in the Plyometric group, and in the Squat group, was moderately improved. However, there was no statistically significant difference in the improvement in CPT between the Plyometric group and the Squat group at any low to high angular velocity (Fig.4-b).

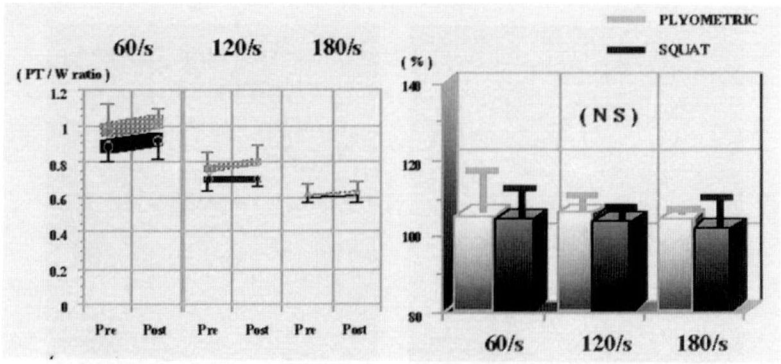


Fig. 4-a
Pre-and post-training peak torque-weight ratio [Concentric]

Fig. 4-b
Improvement ratio of concentric peak torque (CPT).

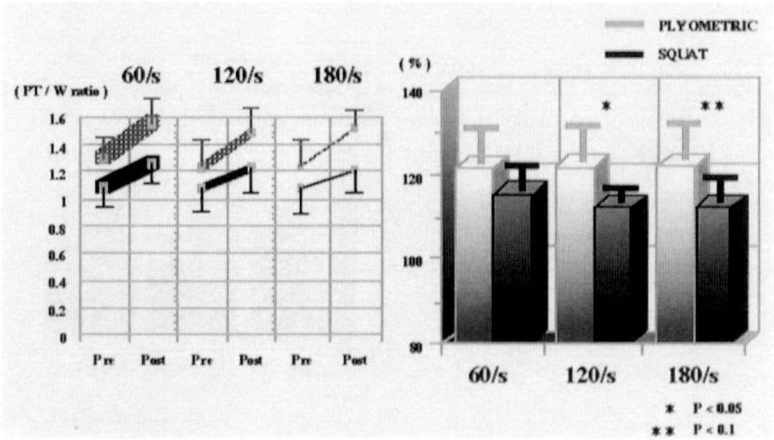
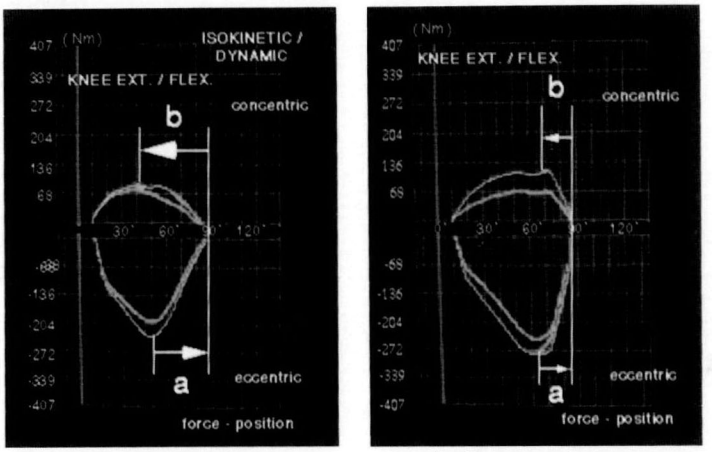


Fig. 5-a
Pre- and post-training peak torque-weight ratio [Eccentric]

Figure 5-b
Improvement ratio of eccentric peak torque (EPT).

The eccentric pre- and post-training peak torque:weight ratio of the quadriceps femoris is shown in Figure 5-a. The eccentric peak torque (EPT) was improved greatly in the Plyometric group, and moderately in the Squat group. As to the improvement in EPT, there was no significant difference between the 2 groups at 60 degrees/sec angular velocity, as the low contraction velocity. However, at 120 and 180 degrees/sec angular velocity, as the middle and high contraction velocities, the Plyometric group had a significantly better improvement ($p<0.05$ at 120 deg/sec, and $p<0.1$ at 180 deg/sec) in EPT than the Squat group (Fig.5-b).

Typical pre- and post-training torque curves and PID are shown in Figure 6. At the time of post- training, the peaks of both the eccentric and the concentric torque curves were shifted to the right. As a result, the PID was shortened. This indicated that there was improvement in the acceleration of muscle contraction. PIDs were shortened after training in the Plyometric group (Fig.7-a). The improvement in PID in the



a. Pre-training b. Post-training

Fig. 6 Pre- and post-training peak interval distance (PID).

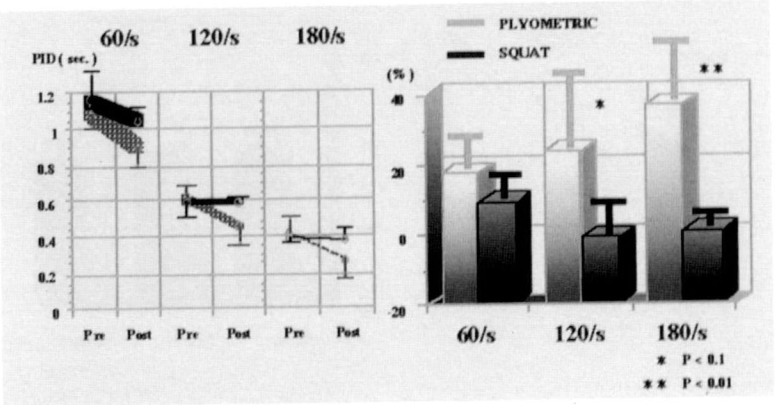


Fig. 7-a Pre- and post-training peak interval distances (PID).

Fig 7-b Improvement ratio of PID.

Plyometric group was significantly higher than in the Squat group at the middle (120 deg/sec, $p<0.1$) and at the high (180 deg/sec, $p<0.01$) angular velocity (Fig.7-b).

Discussion

Drop-jump training, as a plyometric exercise, is considered to be a most effective training method to improve the explosive muscle activities of the lower extremities. It was rumoured that the Russian athlete who won the 100 and 200 m dash in the 1972 Munich Olympics-Valery Borzov-utilized plyometric drills as part of his training[17]. A description of this plyometric drop-jumping exercise was found in a translated Russian paper by Verhoshanski[16]. The first study into the effects of the drop-jumping technique was conducted by Cavagna et al.[8], who had subjects perform a squatting jump and, upon landing, immediately start a new jump. Since the nineteen seventies, several papers have been published about the effect of this method to improve jumping abilities[3)-7),9)-15)], but no reports have concentrated on the effects of open

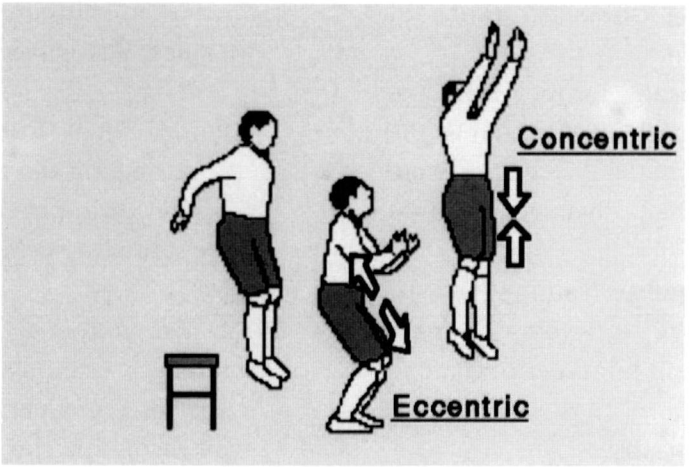


Fig. 8 Drop jumping.

isokinetic movements on the eccentric quadriceps contraction.

Vertical jumping ability is one of the factors determining performance in a variety of sports, such as volleyball and basketball[2], In drop-jumping movements, the knee extensor muscles perform two different contractions. On landing, they contract eccentrically, and then immediately contract concentrically to take off (Fig.8). In jump performances, it is most important to obtain explosive eccentric force and acceleration in muscle contraction. According to Bobbert et al.[1], the speed of prestretch of the knee extensors is greater, and the delay between prestretch and concentric action is shorter in drop jumps than in countermovement jumps.

In this study, high speed (60 times/min) squat exercise was chosen for comparison with the drop-jump exercise. The high-speed squat exercise has a shorter prestretch time and a higher eccentric load of the knee extensors than the slow squat exercise. The high-speed squat exercise was also expected to improve the eccentric contraction force and the speed of the knee extensors.

In both the Plyometric group and the Squat group, the eccentric peak torque of the quadriceps femoris improved at every angular velocity, from low to high. But the peak interval distance improved only in the Plyometric group. The Plyometric group had a significantly higher improvement in eccentric peak torque and in peak interval distance at middle and high angular velocities than the Squat group (Fig.5-b, 7-b). From these results, it seemed that both plyometric drop-jump training and high-speed squat training were each effective in improving the eccentric force of the quadriceps femoris, while the plyometric drop-jump training was effective in improving the explosive eccentric force and the acceleration of the muscle contraction of the quadriceps femoris.

Plyometric drop-jump training strengthened the eccentric force of the quadriceps femoris with speed movements. Therefore, the plyometric drop-jump training can be considered effective to develop stronger and quicker skills in jump performances for competitive volleyball players.

Conclusions

1. We studied the effects of Plyometric drop-jump training on the quadriceps femoris muscle of female volleyball

players, employing isokinetic testing of muscle contraction.

2. The eccentric peak torque and the acceleration of muscle contraction at the middle and high angular velocities were improved by the Plyometric jump training.
3. Plyometric drop-jump training can be considered effective to develop stronger and quicker skills in jump performances.

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Incidence of Partition in the Hallucal Sesamoid in Females: Comparison between Athletes and Control

女性における母趾種子骨分裂の出現頻度
－スポーツ選手と一般女性との比較－

Suguru Torii　鳥居 俊

●Key words
Partition in the hallucal sesamoid : Female athletes : Etiology
母趾種子骨分裂，女子スポーツ選手，疫学

●Abstract
The incidence of a partition in the hallucal sesamoid was examined in female athletes, and in controls without experience of competitive athletic activity, between the third and tenth decade. The incidence was significantly higher in athletes than in controls. In athletes, partition was more frequent in the left foot than in the right foot, and more frequent in basketball and volleyball players than in long-distance runners. In controls, the partition was higher in those younger than forty. In contrast, the incidence of os tibiale externum was similar in both groups. These results suggested that athletic activities that give rise to high foot impaction may be a cause for partition in the hallucal sesamoid.

●要旨
母趾種子骨の分裂がスポーツ選手に多発するか否かを知るため、両足のX線撮影を行った女子スポーツ選手80名と特にスポーツ経験のない20才代から90才代までの一般女性224名を対象に分裂の出現頻度を比較した。母趾種子骨分裂はスポーツ選手で有意に高頻度であり、スポーツ選手では右足より左足に、また長距離走選手よりバスケットボール・バレーボール選手で高頻度であった。一般女性では30才以下で出現頻度が高かった。対照疾患として検討した外脛骨の出現頻度は両群間に差がなかった。
母趾種子骨分裂の出現には足部への衝撃負荷の高いスポーツ動作の関与が推測される。

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Introduction

A partition in the hallucal sesamoid (SP) is a common finding on the X-ray of an athlete's foot, whether it is symptomatic or not. However, no survey has been done on the incidence of SP in athletes, so it is not yet known whether or not acquired pathogenesis such as athletic activities causes SP. In order to investigate the pathogenesis of SP, a survey was undertaken in female athletes and control women.

Materials and methods

Female competitive athletes (athletic group) and women without any experience of competitive athletic activity (control group) were recruited. The athletic group include 80 subjects, aged 15-32 years (mean±SD=20.2±3.7).

Their types of athletic activity were track and field (57 subjects), basketball (7 subjects) volleyball (5 subjects), gymnastics and rhythmic sportive gymnastics (5 subjects) and others (Table 1).

The control group include 224 subjects with a history of no foot injury and no arthritis that affected the hallux. Their age distribution is shown in Figure 1. An A-P radiograph of the bilateral feet was taken for each subject in standing position and examined for any partition in the tibial hallucal sesamoid or the

Table 1 Athletic Activity in the Athletic Group

Type of activity	No.
track & field	57
sprint (100-400m)	17
long distance (800m-marathon)	33
jump (long. high)	4
throw (shot put, discus and javelin)	3
basketball	7
volleyball	5
gymnastics & rhythmic sportive gymnastics	5
others	6

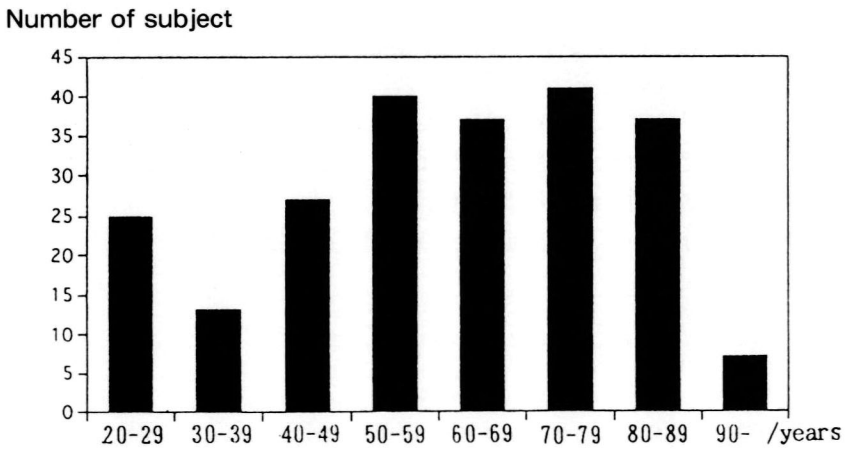

Figure 1 Age distribution of the control group

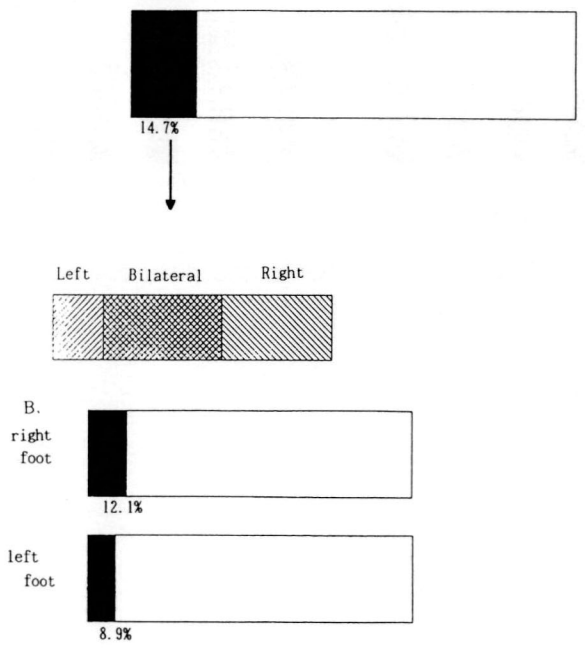

Figure 2 Incidence of SP in the control group

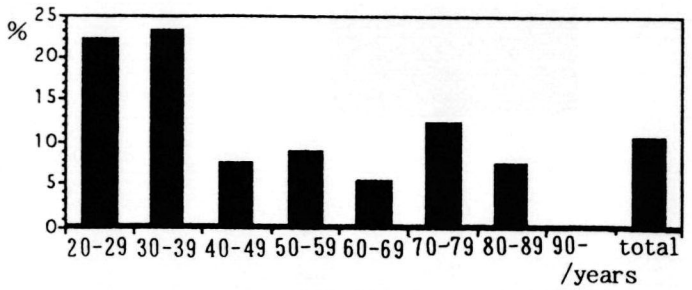

Figure 3 Incidence of SP in the different age populations in the control group

os tibiale externum (TE).

The incidence of SP and of TE was compared between the athletic group and the control group.

Student's t-test was used for statistical analysis of the incidence.

Results

(1) Incidence of SP : In the control group, SP was found in 33 subjects (14.7%) occurring in 47 feet (10.5%). SP was found bilaterally in 14 subjects (6.3%), in only the right foot in 13 (5.8%) and in only the left in 6 (2.7%).

The overall incidence of SP in the right foot was 12.1% (27 feet) and in the left foot was 8. 9% (20 feet), with no significant difference between the right foot and the left foot (Fig. 2-A,B).

The incidence of SP according to age in the control group is shown in Fig.3. In the third and fourth decades, the incidence exceeded 20 %, which was significantly higher than in those in the fifth or higher decades.

In the athletic group, SP was found in 42 subjects (52.5%) occurring in 68 feet (42.5%). significantly more than in the control group SP was found bilaterally in 26 subjects (32.5 %), in only the right foot in 2 (2.5%) and in only in the left foot in 14 (17.5%). The overall incidence of SP in the right foot was 35.0% and in the left foot was 50.0% (Fig.4-A B).

The relationship between the type of athletic activity and the incidence of SP was also investigated. The athletes who participated in basketball or volleyball showed a higher incidence of SP than long-distance runners (Fig.5).

(2) Incidence of TE : In the control group, TE was found in 86 subjects (83.8%) occurring in 115 feet (34.6%). TE was found bilaterally in 69 subjects, and unilaterally in 17 (8 in the right foot and 9 in the left foot). The incidence of TE in the right foot was 34.6% and in the left foot was 34.8% (Fig.6-A,B). The incidence of TE did not vary by age (Fig.7).

In the athletic group. TE was found in 34 subjects (42.5%) occurring in 59 feet (36.9%), similar to the incidence in the control group. TE was found bilaterally in 25 subjects and unilaterally in 9 (3 in the right foot and 6 in the left foot). The incidence of TE in the right foot was 35.0%, and in the left foot was 38.8%

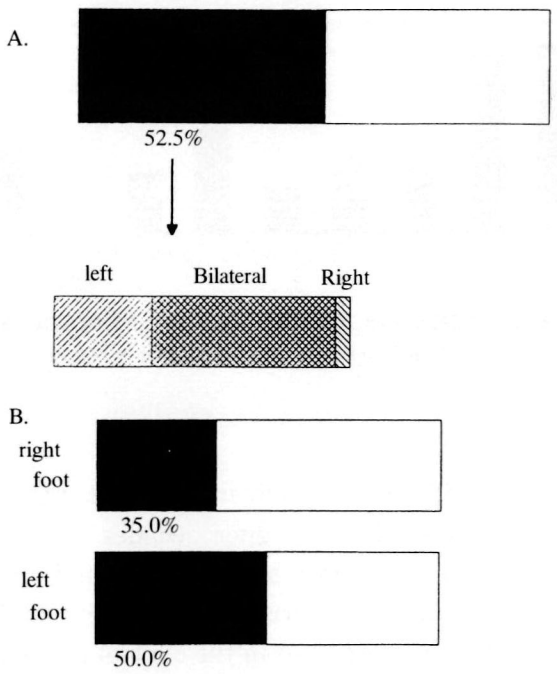

Figure 4 Incidence of SP in the athletic group

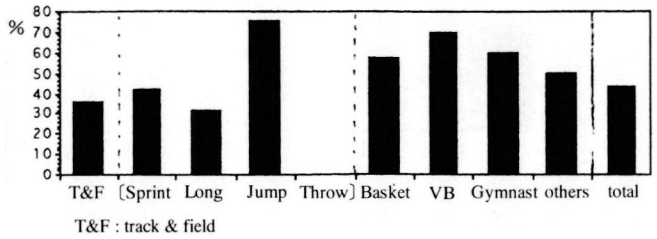

Figure 5 Incidence of SP in the different athletic groups

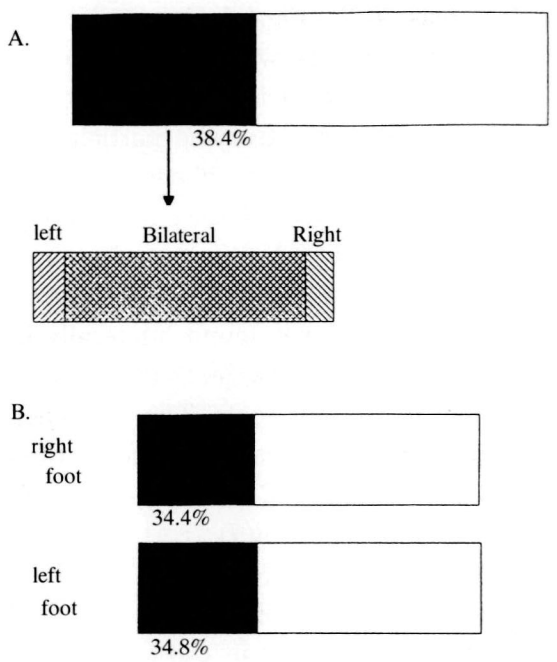

Figure 6 Incidence of TE in the control group

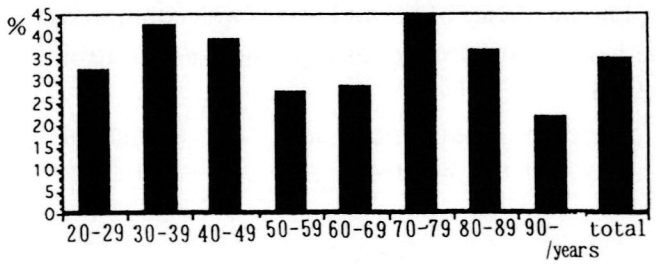

Figure 7 Incidence of TE in the different age populations of the control group

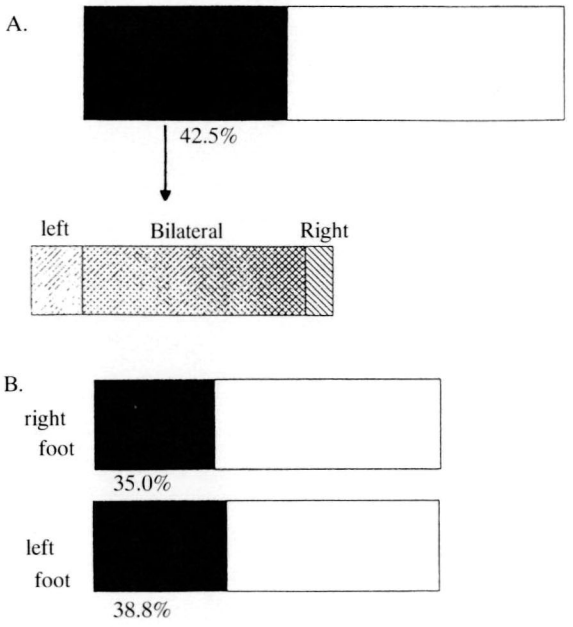

Figure 8 Incidence of TE in the athletic group

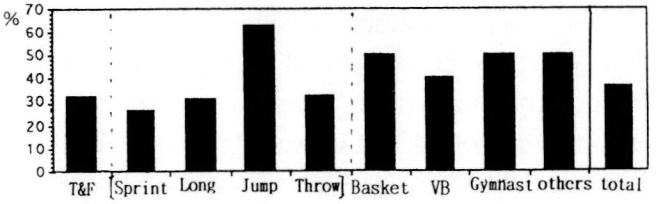

Figure 9 Incidence of TE in the different athletic groups

(Fig.8-A,B), with no significant difference in the incidence of TE between different athletic activity (Fig.9).

Discussion

SP of the hallux has been known as one cause of foot pain in athletes, and its occurrence is not rare. However, asymptomatic SP is occasionally discovered on the radiograph of an athlete's foot.

Ossification of the hallucal sesamoid occurs after 8 years old. In some cases, the ossification center of the sesamoid is originally multiple[1].

The incidence of SP on a radiograph has been reported as 33.5% by Kewenter (in 1588 feet)[2] and as 10.7% by Inge and Ferguson (in 1025 feet)[3]. Kewenter described that most SP occurred unilaterally and only one-quarter occurred bilaterally[2].

The possible causes of SP include a congenital abnormality (partition) of the ossification center, acquired trauma to a single ossification center (a single bout of trauma or repetitive stress), and failure in the union of multiple ossification centers.

In order to determine the etiology of SP, I compared the incidence of SP in female competitive athletes and in control women, and also investigated the incidence of TE.

The finding of the incidence of SP were similar to those of Inge and Ferguson[3], with a higher incidence in younger than 50 years. The latter suggests the possibility of the partite sesamoid uniting in adulthood.

The incidence of SP in the sthletic group was four times higher than in the control group, and twice as high as that in the young population of control group in the third and fourth decade. In order to determine which type of athletic activity was related to the development of SP, the relationship between each type of activity and the incidence of SP was investigated. The incidence was higher in athletes of volleyball, basketball and in long or high jumpers ; their feet were thought to be exposed to high impaction such as jumping, landing and stopping. Although the reason why SP was more frequent in the left foot remains unclear, the left foot of right-handed athletes tends to be their supporting foot, so that, the left foot sustains larger stress than the right foot.

Finally, the incidence of TE was examined

and found to be similar in both groups and in different age populations, which suggested that TE was related to congenital factors. Since, it is impossible that athlete's feet have a different genetic background to the feet of the controls, SP likely occurrs as a result of acquired development.

Conclusion

The incidence of partition in the hallucal sesamoid was higher in female athletes than in control women. These findings suggested that athletic activities with high impaction to foot induced partition.

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X-ray Findings of the Lumbar Spine of Judo Players

柔道選手の腰椎X線所見

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●Key words
Judo player : Spondylolysis : Degenerative change
柔道選手，腰椎分離，変性変化

●Abstract

Purpose of this study was to investigate the influence of adolescent judo performance on the lumbar spine using the X-ray findings. Eighteen judo players were underwent examination using plain radiographs.

On the A-P view, scoliosis, spina bifida occulta, spur formation and a fracture of the transverse process were observed. On the lateral view, we observed narrowing of intervertebral disc space, wedged vertebra, Schmorl's nodule, spur formation and spondylolisthesis. Spondylolysis was observed on the oblique view.

We found spondylolysis in 10 (56%) of the 18 players and 2 of these had spondylolisthesis. Wedge vertebrae were found in 1st and 2nd lumbar vertebra and the distribution of Schmorl's nodule was similar to that for the wedged vertebrae. Spur formations were observed more in the upper lumbar vertebrae than lower lumbar spine.

We concluded that these findings were signs of remnant injury of adolescent judo performance. In particular, the wedge vertebra and Schmorl's nodule were results of a damaged end plate.

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●要旨

本研究の目的は柔道選手の腰椎X線写真を観察し、腰椎に対する成長期柔道の影響の検討を行うことである。18人の実業団男子柔道選手に対し腰椎X線検査を行った。前後像では側彎、潜在性二分脊椎、骨棘形成、横突起骨折、側面像では、椎間板腔狭小化、楔状椎、シュモール結節、骨棘形成、腰椎分離すべりが観察された。腰椎分離は斜位像で確認した。第5腰椎分離が18名中10名にみられ、そのうち2名が分離すべりであった。楔状椎は第1、第2腰椎にみられ、シュモール結節の分布も同様に上位腰椎に多かった。骨棘形成は、下位腰椎に比べて上位腰椎に多く観察された。これらの所見は、成長期柔道の腰椎に対する影響を示す所見と考えられた。

Introduction

Judo is one of a traditional and a popular sports in Japan. Many people play judo, so we often observe sports injury of judo players. Most judo players begin to practice judo in their childhood. Sport injuries in adolescent judo players occur frequently.

The purpose of this study was to investigate the influence of judo performance on the lumbar spine in adolescence.

Subjects

The subjects of our study were 18 judo players who participated in the national championships of Japan. They were ranging from 19 to 32 years and their average age was 23.6 years. Their average height was 178 cm (171～188cm) and their average weight was 103kg (80～138kg). They had begun to practice judo at about 10 years old (5～16years old), and had been training for 5 to 23years. Their average judo experience was 13 years. They were training for 3 hours a day and 6 days a week.

The class of judo was as below. Eight players were in +95kg, 7 members entry in −95kg, only one was in −86kg and three were in −78kg class.

Methods

Each player underwent plain radiographs of the lumbar spine (A- P view, lateral view, and two oblique views) and interviewed to determine any episodes and complaints of low back pain.

Results

1. Complaints of low back pain

Fifteen of the 18 players had experienced of low back pain and 10 were currently suffering from lumbago during the period of this study. However no player developed any neurological deficit.

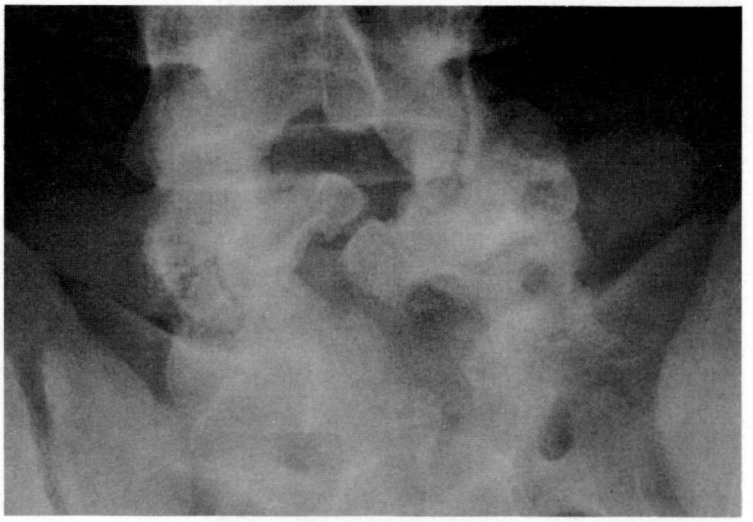
2. X-ray findings

The X-ray findings are presented in figures 1 and 2.

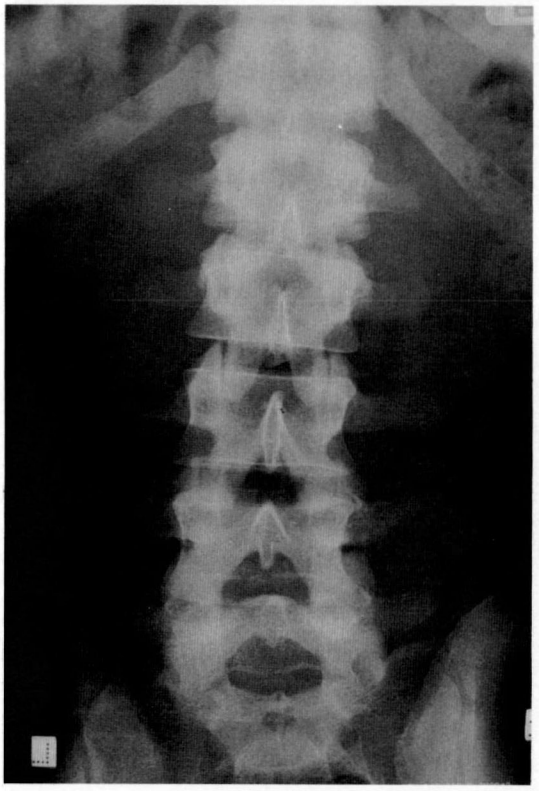
On the A-P view, scoliosis (Fig.1-a), spina bifida occulta (Fig.1-b), spur formation (Fig.1-c) and a fracture of transverse process were observed. On the lateral view, we found narrowing of intervertebral disc space (Fig.2-a), Schmorl's nodule (Fig.2-b), spur formation (Fig.2-c), wedged vertebra (Fig.2-d) and spondylolisthesis (Fig.2-e). Spondylolysis was confirmed on the oblique views (2-f).

Spondylolysis was found in 10 of the 18

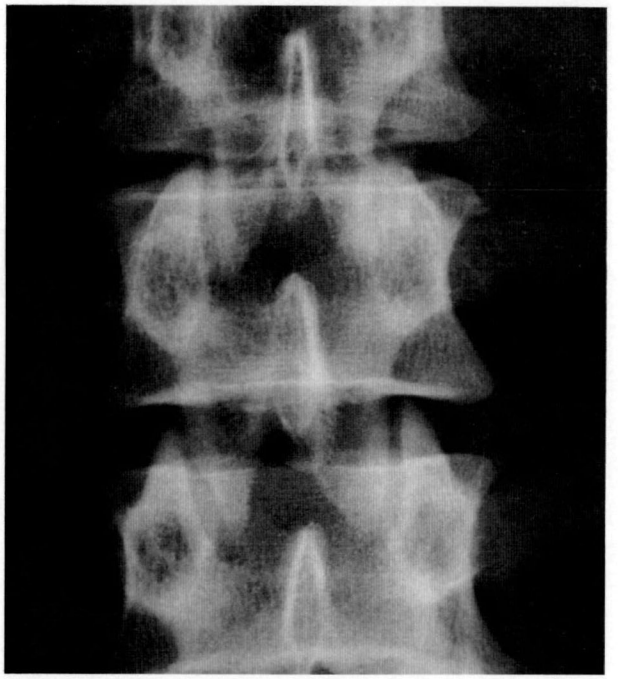
players (56%). All 10 cases involved the 5th lumbar vertebra. Eight were bi-lateral type and 2 were uni-lateral type. The Side of the uni-lateral type was left side in both. Two of the 8 bilateral type had spondylolisthesis. And 6 of the 10 had spina bifida occulta.



1-b ; Spina bifida occulta



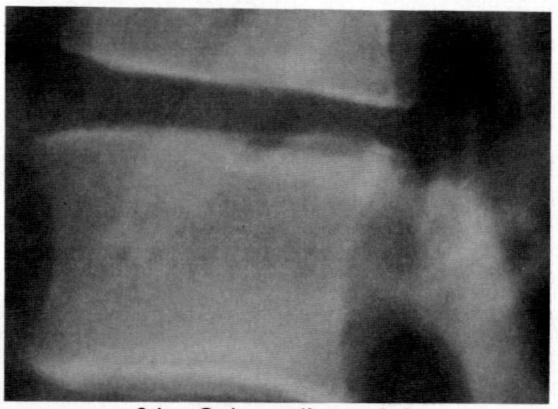
1-a ; Scoliosis



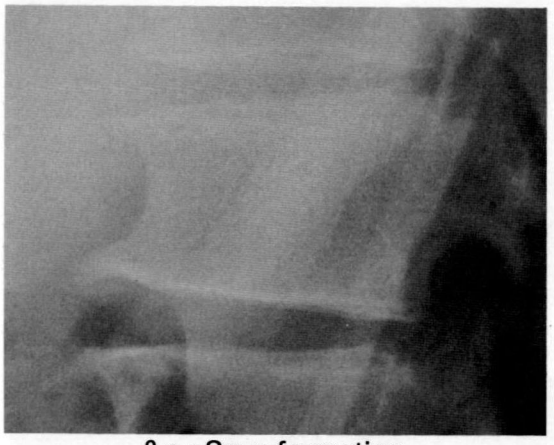
1-c ; Spur formation

Fig.1 ; X-ray findings on the A-P view

2-a ; Narrowing in the intervertebral disc space



2-b ; Schmorl's nodule



2-c ; Spur formation
2-d ; Wedge vertebra

2-e ; Spondylolisthesis

2-f ; Spondylolysis

Fig.2 ; X-ray findings on the lateral and oblique views

Wedge vertebrae were found in 7 cases involving the 1st lumbar vertebra in 7 and the 2nd in 3 (Table 1).

Spur formations were found more frequently in the upper lumbar vertebrae than in the lower lumbar vertebrae (Table 1).

In the vertebral disc space, narrowing of disc space was found in 3 cases. Schmorl's nodule was found in 4 cases involving L1/2 in 3 and L2/3 in 3 (Teble 2).

Discussion

Top level Judo players in Japan usually begin to practice judo in their childhood and sports disorders frequently occur during the growth period of adolescence. Judo is a combative sport and judo practice have in common repetitive flexions, extensions, or rotations of the lumbar spine with heavy loads on their back. This practice increases the risk for injury to the

Table 1 Distribution of wedge vertebra and spur formation

Level	Wedge vertebra	Spur formation
L1	7	7
L2	3	7
L3	0	6
L4	0	2
L5	0	2

Table 2 Findings in the Intervertebral disc

Level	Schmorl's nodule	Disc space narrowing
L1/2	3	1
L2/3	3	0
L3/4	0	0
L4/5	0	0
L5/S1	0	2

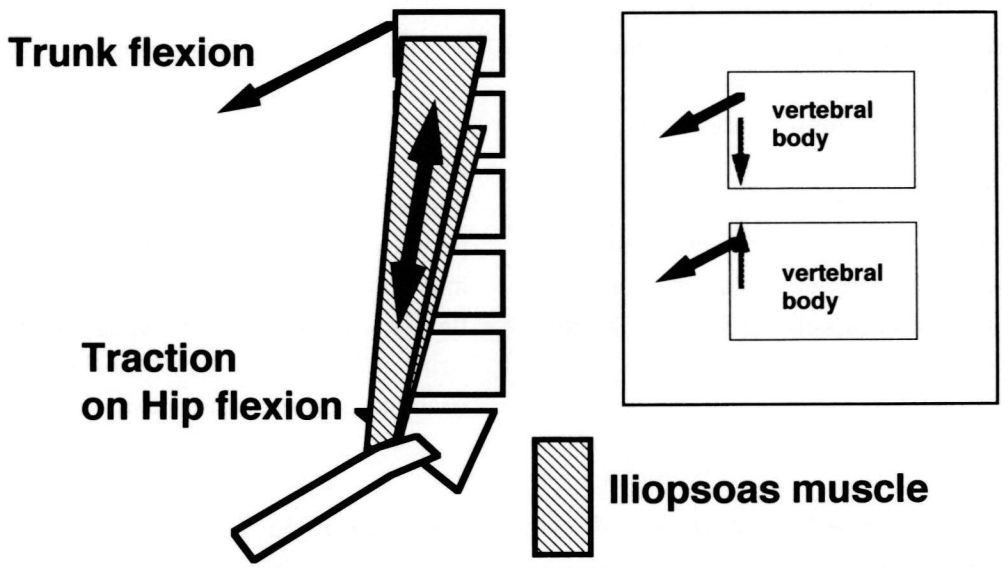


Fig.3 ; Mechanisim of wedge vertebrae and spur formation in the upper lumbar vertebrae.

structures of the spine. In judo performance, especially when practicing the throwing technique, movements by lumbar spine are repeated rapidly. This motion is so overload to the pars interarticularis that spondylolysis occurs in judo athletes frequently. High incidence of spondylolysis was explained these reason. The incidence rate of spondylolysis of our subjects was 56%. Ichikawa[5] reported the incidence of spondylolysis in judo athletes 29.2% and Yamaji[2] reported an incidence of 20.2 % in college judo players. We have previously reported an incidence rate of 33.3%. And here in this report an incidence rate of 56%. In this study, we took X-rays of the lumbar spine of all members including those with and those without experience of back pain. Previously, we examined those with low back pain. It suggest that some players had spondylolysis without back pain.

In this study, we found wedged vertebra and spur formation more frequently in the upper vertebrae than lower vertebrae. Swärd et al,[4] reported that apophyseal abnormalites were only seen among athletes and most frequently among wrestlers and female gymnasts. They suspected the biomechanical reason was that the traction forces acted over the anterior part of the spine during contraction of diaphragm muscles. We suspected this reason described as follows. In judo, movements of the trunk occur with flexion of the hip joint We propose that contractions by the iliopsoas and psoas muscles are vertically applied to the upper vertebrae, so compression stress occurs at the anterior part of vertebral body. As a result of this, wedge deformities and spur formation are observed in the upper vertebra rather than in the lower lumbar spine.

The repetitive flexions and extensions of thoracolumbar junction in young judo players, can cause multiple growth plate fractures and bony deformation in the vertebrae. As a result, wedge deformity, Schmol's nodule and spur formation were discovered as signs of the remnant influence of a damaged end plate from repetitive judo practice during their adolescence.

Conclusions

1. In this study, judo players showed high incidence of spondylolysis (56%).
2. No new of developing spondylolysis was found.
3. Wedge deformity and spur formation were found frequently in the upper lumbar vertebrae.
4. Findings suggested the influence from injuries incurred their repetitive judo practicw during adolescence.

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Graft Isometry in Anterior Cruciate Ligament Reconstruction

膝前十字靱帯再建術における移植腱の等尺性の意義

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●Key words
Anterior cruciate ligament Reconstruction : Isometry
前十字靱帯，再建術，等尺性

●Abstract

We have measured the changes in distance between the tibial and femoral bone tunnels during passive knee motion in anterior cruciate ligament reconstruction, and have investigated the effects of graft isometry on postoperative knee stability. Forty-six patients who had undergone ACL reconstruction using one-third patellar tendon augmented with a Leeds-Keio augmentation device were studied. There were 27 males and 19 females, with a mean age of 24.5 years. KT-10000 arthrometer measurements at 20° knee flexion with 90 N force were performed at about one year after surgery. The change in length between the tibial bone tunnel and femoral bone tunnel, during passive knee motion from 0°to 120° ranged from 0.5 to 7 mm with a mean of 3.2±1.4 mm. The mean change in length was 3.6±1.6mm in the over-the-top pattern, 5.2±1.0mm in the reverse over-the-top pattern, and 2.9±1.3mm in the combined pattern. The mean change in length was significantly smaller in the combined pattern than in the reverse over-the-top pattern. The postoperative injured-to-uninjured difference in anterior knee laxity by KT 1000 measurements, ranged from −3 to 7mm, with a mean of 1.9±2.2mm. The injured-to-uninjured difference, by KT 1000 measurements, was significantly smaller in patients with a change in length of 4 mm or less than in patients with a chaneg in length of more than 4 mm. Graft isometry was concluded to be significantly related to postoperative knee stability.

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●要旨

膝他動運動時おける脛骨・大腿側の骨孔間の距離変化を前十字靱帯再建術中に測定し，移植腱の等尺性が術後膝安定性に与える影響を検討した。対象は膝蓋腱とLeeds-Keioメッシュ補強材を用いて前十字靱帯再建術を受けた46例で，男性27例，女性19例で，平均年齢は24.5歳であった。KT-1000 arthrometer 計測は膝屈曲20°で，90Nを負荷しておおよそ術後1年時に行なった。0°～120°の膝他動運動時おける脛骨・大腿側の骨孔間の距離変化は0.5～7mm，平均3.2±1.4mmであった。over the top pattern における平均距離変化は3.6±1.6mm，reverse over the top patternは5.2±1.0mm，combined patternは2.9±1.3mmであった。combined patternにおける平均距離変化は，reverse over the top patternに比較して有意に小さかった。KT 1000計測における膝前方動揺性の患健側差は－3～7mmに分布し，平均1.9±2.2mmであった。また，距離変化が4mm以内の症例のKT1000患健側差は，4mm以上の症例に比較して有意に小さかった。移植腱の等尺性は術後膝安定性に有意に関連すると結論された。

INTRODUCTION

Graft isometry is an important factor in the success of anterior cruciate ligament (ACL) reconstruction. Graft placement is crucial, and improper graft placement is known to produce excessive tension in the graft during flexion or extension of the knee that can result in graft failure or limited motion. Recognition of these problems has led to the study of isometric graft placement [4),9)].

However, recommended graft placements [2),10)] have varied from study to study, and also the knee shape and size vary from patient to patient. Therefore, it is desirable to select the optimum graft placement to obtain isometric performance for each patient during surgery. The purpose of this study was to measure the changes in distance between the tibial bone tunnel and the femoral bone tunnel during passive knee motion, and to determine how graft isometry affected the postoperative knee stability following ACL reconstruction.

MATERIALS AND METHODS

Patient population

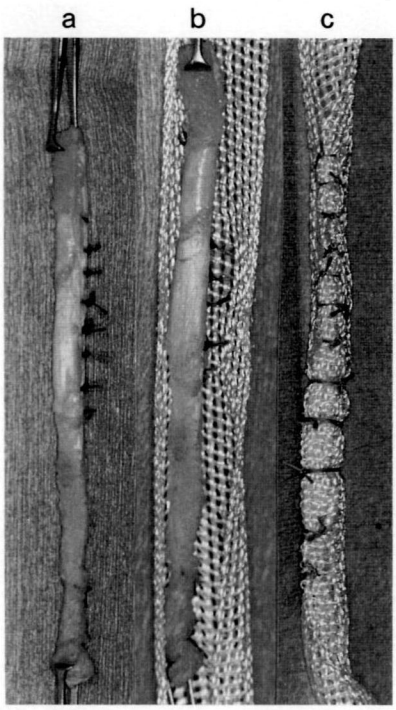
Between 1991 and 1993, 57 patients underwent ACL reconstruction[6),7)] using one-third patellar tendon augmented wih a Leeds-Keio augmentation device [3)]. Forty-six of them who had had a one-year follow-up examination were studied. There were 27 males and 19 females, with a mean age of 24.5 years (range : 14-45 years). The mean interval from injury to surgery was 18.5 months. Thirty-two patients had associated injury ; 14 patients of them had meniscal tears, and 10 had medial colateral ligament injuries.

KT-1000 arthrometer measurements were performed at 20° knee flexion with 90 N force. The thigh circumference was measured at 10 cm proximal to the patella.

Intraoperative measurement of graft isometry

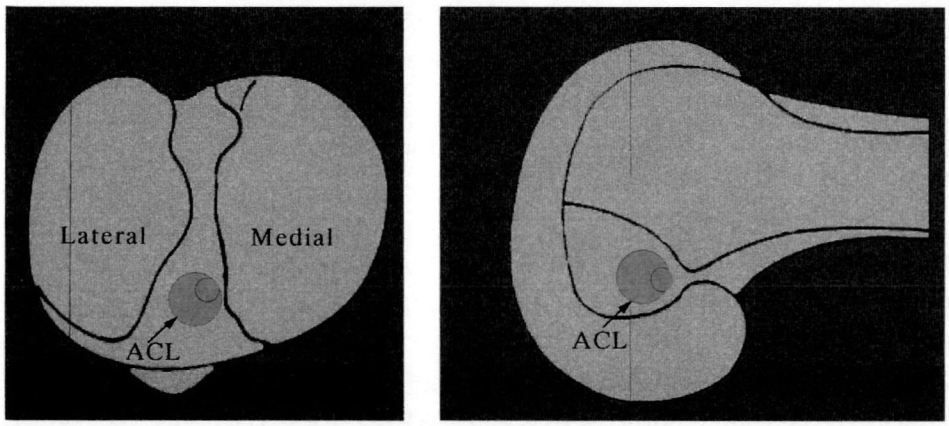
One-third of the patellar tendon with bone blocks on both ends was harvested, and was tubed with absorbable sutures (Fig. 1). Woven polyester was sutured tightly around the patellar tendon to make a composite graft with a diameter of 8 mm.

The tibial graft placement was identical in each ACL reconstruction (Fig. 2). A tibial bone tunnel with a diameter of 8 mm was made in the posteromedial portion to the center of the



a. One third of the patellar tendon with bony tissues.
b. Woven polyester is sutured around the patellar tendon.
c. composite graft with the patellar tendon and woven polyester.

Fig. 1 Surgical technic of composite graft formation.



The tibial graft placement was identical in cach ACL reconstruction. A tibial bone tunnel with a diameter of 8 mm was made in the posteromedial portion to the center of the anatomic ACL insertion. Then a guide wire was inserted into the posterosuperior margin of the lateral intercondylar notch.

Fig. 2 The position of the tibial bone tunnel and the femoral bone tunnel.

anatomic ACL insertion. Then a guide wire was inserted into the posterosuperior margin of the lateral intercondylar notch. A TEVDEK suture, which was used as the trial substitute, was connected to the distal end of the guide wire. The suture was passed through the tibial bone tunnel, and connected to the isometer. Changes in the distance between the tibial bone tunnel and the femoral pilot tunnel during passive knee motion from 0° to 120° were

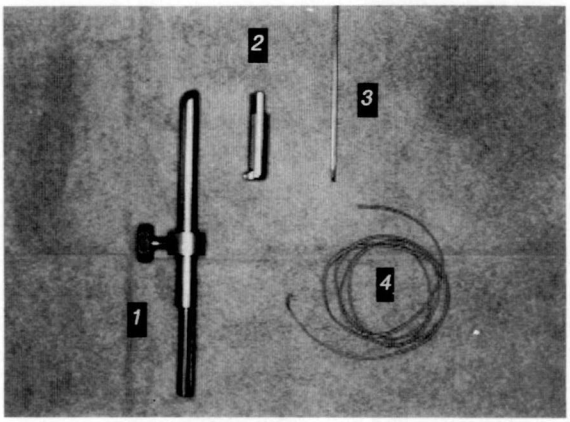


Fig. 3a The isometer.
1 : tibial device, 2 : femoral device
3 : guide wire, 4 : TEVDEK suture

Fig. 3b Intraperative measurement of graft isometry.

measured using the isometer (Fig. 3a,b). If the first measurement showed that a change in length exceeded 4 mm, the position of the guide wire was altered to produce more isometric performance. The guide wire was overdrilled to make a femoral bone tunnel after a desirable position in the pilot tunnel had been selected. Finally, the change in the distance between the tibial bone tunel and the femoral bone tunnel was measured with a special femoral device.

The graft was passed through the tibial tunnel and the femoral tunnel, and fixed to the femur with 2 staples and to the tibia with a screw. After fixation of the graft, the knee was put through a full range of motion (ROM) to ensure proper tightness of the graft. A notch plasty was performed if the graft was impinged in the intercondylar notch.

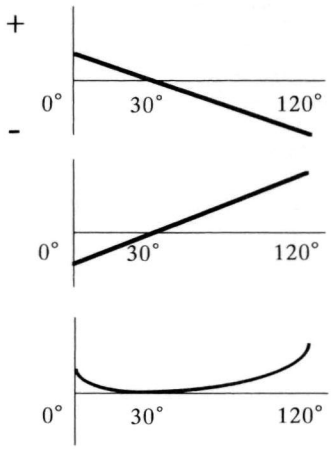
rehabilitation

A hinged brace was applied immediately after the operation. On the third postoperative day, range of motion exercise on the CPM device and isometric quadriceps exercise were begun. Partial weight bearing was allowed at 2 weeks after surgery, increasing to full weight bearing at 6 weeks. Isotonic muscle exercise was started at 2 weeks and isokinetic muscle exercise with ARIEL-CES (180 deg/sec) at 4 weeks postoperatively. The hinged brace was removed at 12 weeks, and sports were allowed at 16 weeks postoperatively.

change in length and length pattern

By definition, "isometric" means no change in length of the tibiofemoral bone tunnel during knee motion. For this study, we defined a position of the bone tunnel with a maximum change in length of 4 mm as isometric.

The length patterns were divided into 3



1) over-the-top pattern : when the length decreased with knee flexion.
2) reverse over-the-top pattern : when the length increased with knee fexion.
3) combined pattern : when the length initially decreased, and then subsequently increased with knee flexion.

Fig. 4 Lenght patterns.

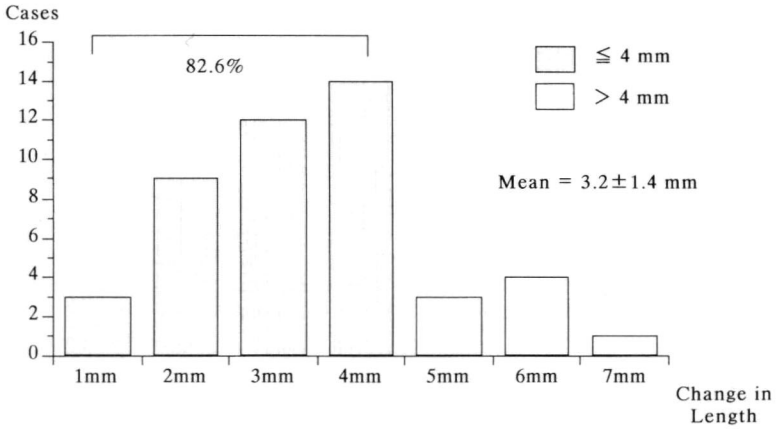


Fig. 5 The change in length between the tibial bone tunnel and the femoral bone tunnel.

patterns as follows (Fig. 4) ; 1) over-the-top pattern : when the length decreased with knee flexion. 2) reverse over-the-top pattern : when the length increased with knee fexion. And 3) combined pattern : when the length initially decreased, and then subsequently increased with knee flexion.

The stastical analysis was performed using ANOVA and chi square test, and $p=0.05$ was accepted as the minimum level of significance.

RESULTS

The change in length ranged from 0.5 to 7mm, with a mean of 3.2±1.4mm. Thirty-eight (82.6%) of the 46 patiens showed a chaneg in length of 4mm or less (Fig. 5).

With respect to pattern, 8 patients had an over-the-top pattern, 3 had a reverse over-the-top pattern, and the other 35 had a combined pattern.

Table 1 shows the correlation between the change in length and the lenght pattern. The mean change was 3.6±1.6mm in the over-the-top pattern, 5.2±1.0mm in the reverse over-the-top pattern, and 2.9±1.3mm in the combined pattern. The mean change in the combined pattern was significantly smaller than in the reverse over-the-top pattern.

The postoperative injured-to-uninjured difference by KT 1000 measurement for anterior knee

Table 1 Correlation between the Change in Length and the Length Pattern

	LC	LC≦ 4mm
OT (8)	3.6±1.6 mm	6/8 (75.0%)
ROT (3)	5.2±1.0 mm *	1/3 (33.3%)
Combined (35)	2.9±1.3 mm *	31/35 (88.6%)
Total (46)	3.2±1.4 mm	38/46 (82.6%)

* $p < 0.05$

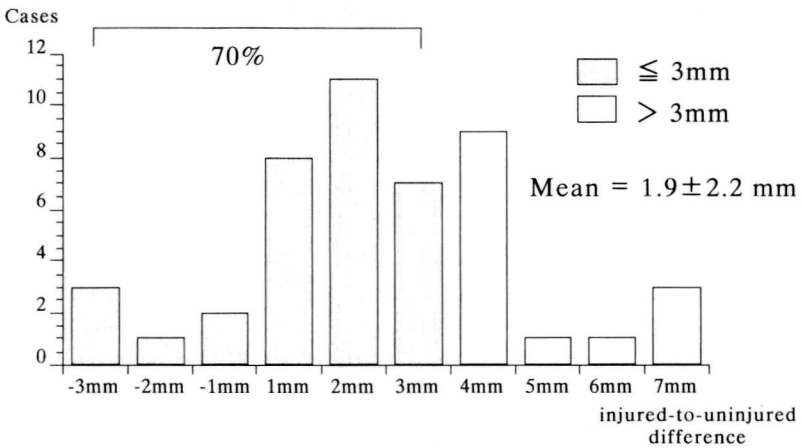


Fig. 6 The postoperative injured-to-unijured difference by KT-1000 arthrometer measurement.

laxity ranged from −3 to 7mm, with a mean of 1.9±2.2mm. In 70% of cases, the difference was 3mm or less (Fig. 6).

The injured-to-uninjured difference by KT 1000 measurement was significantly less in patients with a change in length of 4mm or less than in patients with a change in length of more than 4mm (Table 2).

The mean knee extension was −0.2±1.5° postoperatively, and one patients had a limitation of 10°. The mean knee flexion was 149.3 ±2.5°, and 2 patients had a limitation of 10°, The mean ROM was 149.3±2.5°, and 43 patients (93.5%) had full range of motion. The mean loss of thigh circumference was 0.4±0.6 cm (range : 0 to 2 cm). Loss of 1 cm or less was obtained in 38 patients (82.6%), 1.5 to 2 cm in 8 ; none of the patients experienced loss of 2.5 cm or more.

DISCUSSION

Several factors including graft selection, graft isometry, graft fixation and postoperative rehabilitation[11] affect the results of ACL reconstruction. Of these factors, graft isometry is the most important. Isometric placement may prevent the graft from becoming excessively tense, and can prevent an increase in anterior knee laxity that results from a slackening of the graft as the knee is flexed or extended. In order to achive isometric placement, the graft

Table 2 Correlation between the Change in Length and the Postoperative Injured-to-Uninjured Difference by KT-1000 Arthrometer Measurement

Change In Length	Injured-to-Uninjured Differences by KT-1000	
≦ 4 mm (38)	1.6 ± 2.2 mm	*
> 4 mm (8)	3.5 ± 1.4 mm	
Total (46)	1.9 ± 2.2 mm	

* $p<0.05$

must be correctly placed in the knee, at the time of surgery.

Many experimetal studies have been described with different recommendations for tibial and femoral graft placement. At the tibial site, the recommended placement has included the anteromedial, central or posteromedial portions for the anatomical insertion of the ACL. At the femoral site, insertion of the ACL has been recommended in the posterior or posterosuperior margin.

However, there are various problems in determining the optimum isometric graft placement at the time of surgery. Most experimental studies have used normal ACL as a target for isometric placement of the graft, but these methods are not readily applicable in ACL-deficient knees. Moreover, isometric points may vary in location from patient to patient because of anatomical variations in the knee. Threfore, it is necessary to select the optimum graft placement for each patient at the time of surgery[8], to obtain isometric performance.

Although isometric placement is an ideal goal that can rarely be achieved, it is possible to position graft placement that minimizes the change in the tibiofemoral distance during knee motion. Arms et al.[1] measured the change in length in the normal ACL using a strain gauge. They found that the upper strain limit of the ACL was about 4 to 5%, beyound which ligamentous disruption began to occur. These results would indicate that the normal ACL has a change in length of 2.5 mm with passive knee motion. In this study, the total length of the graft was approximately 100 mm, and 4% ligamentous strain was therefore equivalent to a 4 mm change in length of the graft. Therefore, a graft placement which produced a change of 4 mm or less was defined as isometric.

Our previous experimental studies using cadaver knees demonstrated that the position of a single-band graft had 3 patterns in terms of change in length during passive knee flexion; 1) an over-the-top pattern was observed in the posterosuperior positioned femoral bone tunnel, 2) a reverse over-the-top pattern in the anterior positioned femoral bone tunnel and 3) a combined pattern in the posterior positoned femoral bone tunnel. In this study, the position of the fermoral bone tunnel with a combined pattern showed the most isometric performance. These results suggested that the most isometric femoral placement site would be at the posterior margin of the lateral intercondylar notch, in most patients.

Many experimental and clinical studies[5),12)] have suggested that isometric placement of the graft increases the chance of restoring the

normal limits of anterior knee laxity following ACL reconstruction. However, to our knowledge, few studies have clearly described the effects of graft isometry on postoperative kneee stability. In this study, the correlation between the change in length of the graft and the postoperative injured-to-uninjured difference by KT-1000 measurement demonstrated that graft isometry was significantly related to postoperative knee stability.

SUMMARY

We measured the changes in distance between the tibial bone tunnel and the femoral bone tunnel during passive knee motion, and demonstrated the effects of graft isometry on postoperative knee stability following ACL reconstruction.

1) The changes in distance between the tibial bone tunnel and the femoral bone tunnel, during passive knee motion from 0° to 120°, ranged from 0.5 to 7 mm, with a mean of 3.2 ±1.4mm.

2) The mean change in length was 3.6±1.6 mm in the over- the top-pattern, 5.2±1.0 mm in the reverse over-the-top pattern, and 2.9±1.3 mm in the combined pattern. The mean change in the combined pattern was significantly smaller than in the reverse over-the-top pattern.

3) The postoperative injured-to-uninjured difference by KT 1000 measurement ranged from −3 to 7mm, with a mean of 1.9 ±2.2 mm.

4) The injured-to-uninjured difference by KT 1000 measurement was significantly less in patients with a change in length of 4 mm or less than in those with a change in length of more than 4 mm.

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Stress Fracture in the Femoral Shaft : A Report of Four Cases

大腿骨骨幹部疲労骨折の4例

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Hiroshi Ikeda 池田 浩 Yasuo Yamauchi 山内裕雄

●Key Words
Stress Fracture : Femoral Shaft : Sports
疲労骨折、大腿骨骨幹部、スポーツ

●Abstract
The femoral shaft is an infrequent site for a stress fracure. Here, we report four cases of a stress fracture that occurred in the femoral shaft of young athletes, involving two soccer players and two long-distance runners. Three of them were treated conservatively with good results, while the remaining one patient required surgery because the fracture was already complete and displaced when he visited our hospital. In three of the four cases, the fracture occurred in the distal third, while in the fourth the fracture ocurred in the proximal third. A stress fracture in the proximal third is rare. Whenever a stress fracture is suspected, carefull examination is required, because initial roentgenograms usually fail to reveal evidence of a stress fracture. Bone scintigrams and MRI examination are extremely helpful, but are not suited for routine use. Athletic training staff should be fully aware of the possibility of a stress fracture when athletes complain of pain in the skeletal structure to enhance early diagnosis and proper treatment for this condition.

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●要旨

大腿骨骨幹部疲労骨折は比較的まれである。今回われわれはスポーツにより生じた４例を経験したので報告する。スポーツ種目は２例がサッカー、２例が陸上であった。４例中３例は保存的に治療され経過良好であったが､1例は初診時すでに転位を伴った完全骨折を認めたため、手術治療を行った。3例は遠位1/3に生じていたが、１例は非常に稀な近位1/3に生じていた。疲労骨折は初診時のレントゲンでは異常所見がみられないことがあり、疲労骨折が疑われた場合には注意深い経過観察が必要である。骨シンチグラフィーやMRIは早期診断に有用であるが、ルーチーン検査にはなり難く、早期診断、早期治療のためにはスポーツ現場のスタッフが本症の認識をもち、スポーツ指導にあたることが重要である。

Stress fractures are common in the lower extremities, and frequently occur in young athletes engaged in excessive training. However, the femoral shaft is a rather uncommon site. Here, we report four cases of a stress fracture which occurred in the femoral shaft of young athletes.

Case reports

Case 1. A 16-year-old boy felt a right thigh pain while playing soccer, in July 1991. He visited a nearby clinic and was diagnosed as having quadriceps muscle strain, and he continued to play soccer. Two weeks later, he felt severe pain in his right thigh whenever he kicked a soccer ball. A careful X-ray examination showed a complete fracture with displacement in the distal femur (Fig.1-a). Open reduction and internal fixation were performed (Fig1-b). There was a periosteal reaction on the fracture site

(a) (b)

Fig.1 Case 1.
(a) X-rays showed a complete fracture with diplacement at initial examination.
(b) Open reduction and internal fixation

Fig.2 Case 2.
(a) X-rays showed no abnormality.
(b) Periosteal reaction at the medial side of the distal femur

at the operation. Although the X-ray examination revealed no callus formation, we suspected that an undiagnosed stress fracture had progressed to become a complete fracture through repetitive minor trauma. It took six months for him to return to sports after the surgery.

Case 2. A 14-year-old boy felt a left thigh pain after a long-distance race, in November 1994. Although an X-ray examination revealed no abnormal findings at the initial examination (Fig.2-a), a stress fracture was suspected, so we

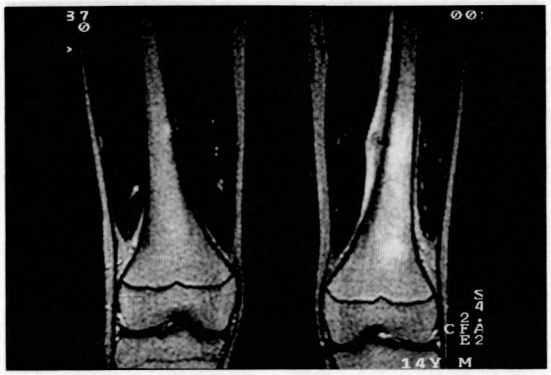

Fig.3 Case 2. At three weeks after the initial examination, MRI showed a periosteal reaction and a fracture in the cortex.

(a) (b)

Fig.4 Case 3.
(a) Periosteal reaction at the proximal third of the femur (b) Two months later

advised him to discontinue sports activities. At 2 weeks after the initial examination, an X-ray revealed a periosteal reaction at the medial side of the distal femur (Fig.2-b). MRI confirmed the periosteal reaction with a fracture of the cortex, consistent with a stress fracture (Fig.3). He was diagnosed as having a stress fracture and treated conservatively by discontinuance of sports activities. He returned to sports at four months after the onset of symptoms.

Case 3. A 16-year-old boy occasionally felt a right thigh pain after playing soccer, in February 1995. One month later, he felt the pain again while he was playing soccer and visited our hospital. Laboratory data, including a blood-cell count and a routine biochemical screening test, were within normal limits. An X-ray examination revealed a periosteal reaction in the proximal third of the right femur, suggesting a stress fracture (Fig.4-a). An MRI confirmed a periosteal elevation with a fracture of the cortex, consistent with a stress fracture. He was diagnosed as having a stress fracture and was instructed to use crutches. At 6 weeks later he started jogging, and returned to sports activities at 2 months after his first visit (Fig.4-b).

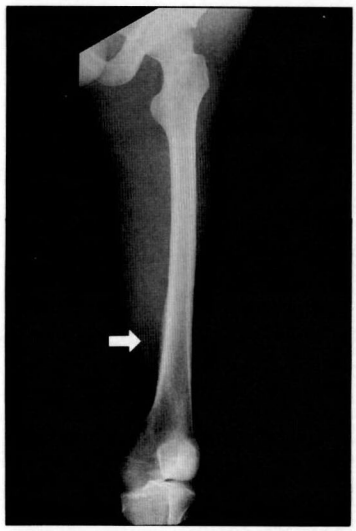

Fig.5 Case 4. Periosteal reaction at the medial side of the distal femur

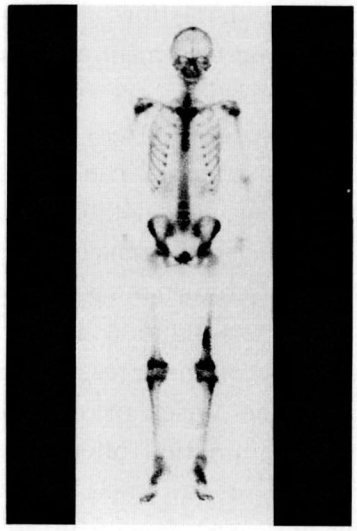

Fig.6 Bone scintigrams demonstrated increased uptake in the distal femur.

Fig.7 MRI showed a periosteal reaction.

Case 4. A 14-year-old boy felt a left knee pain while running, in March 1995. An X-ray examination revealed a periosteal reaction at the medial side of the distal femur (Fig.5). Bone scintigrams demonstrated increased uptake in the distal femur (Fig.6) and MRI confirmed the periosteal reaction at the same site (Fig.7). He was diagnosed as having a stress fracture, and was successfully treated conservatively.

Discussion

Stress fractures commonly occur in young adolescent athletes. While a stress fracture in a lower extremity occurs more frequently in the foot on leg-involving the tibia on metatarsal-involvement of the femoral shaft is rather uncommon[1)2)]. Only 2.6 to 5.5% of stress fractures among athletes occur in the femoral shaft[3)]. The distal third is the usual site for a stress fracture in the femur[3)4)]. In three of our four cases, the stress fracture occured in the distal third. However, the forth case (case 3) occurred in the proximal third, which is rare. As for the etiology of a stress fracture in the distal femur, the femur is most anteriorly curved in its distal third, where it is susceptible to anatomic and dynamic stress[3)5)]. Also, contraction forces of the adductors, quadriceps and gastrocnemius

muscles act on the distal third[5].

Early diagnosis and treatment are important [6][7], so careful examinations are required for a patient with a suspected stress fracture, an undiagnosed stress fracture can progress to become a complete fracture with displacement, as in Case 1. A delayed diagnosis can prevent the patient from early return to sports activities, but an early X-ray examination usually fail to reveal any evidence of the stress fracture. At 2-3 weeks after the onset of symptoms, a standard X-ray examination often documents the healing phase of a stress fracture by demonstrating increased density in he cancellous bone a fracture line or periosteal reaction in the cortical bone [8]. Bone scintigrams and MRI are useful methods especially in the early phase of a stress fracture. They are extremely sensitive for diagnosing a stress fracture and are effective screening tools for patients with clinical findings of a stress fracture but negative roentgenograms[9][10][11]. MRI can be especially helpful for differential diagnosis between a stress fracture and a bone tumor [8], but both bone scintigram and MRI are unsuited as a routine examination. The optimum treatment for a stress fracture is conservative involving abstinence from sports activities. A stress fracture usually heals well with nonoperative treatment. It is important that athletic training staff are fully aware of the possibility of a stress fracture when athletes complain of pain, to enhance early diagnosis and proper treatment of this condition.

Conclusion

1. We reported four cases of a stress fracture which occurred in the femoral shaft of young adolescent athletes.
2. One case occurred in the distal third of the femur.
3. Careful examination is required for a patient with a suspected stress fracture, to help the patient to return early to sports.

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Osteoarthritic Changes in the Patellofemoral Joint after Anterior Cruciate Ligament Reconstruction

前十字靭帯再建術後の膝蓋大腿関節の関節症変化

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●Key words
Anterior cruciate ligament : Osteoarthritis : Complication
前十字靭帯，変形性関節症，合併症

●Abstract

We have evaluated the osteoarthritic changes in the patellofemoral joint after anterior cruciate ligament (ACL) reconstruction using the patellar tendon augmented with woven polyester, and have investigated the factors affecting the incidence of the osteoarthritic changes. Thirty patients who had no osteoarthritic changes or malalignment in the patellofemoral joint before surgery were studied. Twenty-two of these showed no osteoarthritic changes in the patellofemoral joint during a follow-up of 5.7 years (normal group). The remaining 8 patients (26.6%) showed mild osteoarthritic changes in the patellofemoral joint (OA group). Mild patellofemral pain was found in 7 patients of the normal group (31.8%) and in 3 of the OA group (37.5%), and a definite crepitance occurred in 2 patients in each group. The postoperative total Lysholm knee score was 97.0 points in the normal group, and 95.0 points in the OA group. Therefore, osteoarthritic changes in the patellofemoral joint were not correlated with the incidence of patellofemoral symptoms or worse subjective results. There are many factors affecting the development of patellofemoral osteoarthritis after ACL reconstruction such as age, associated injury, level of sports activity, instability, ROM, and muscle strength. In this study, there were significant differences in mean ROM, and in the percentage of ROM limitation, between the 2 groups ($p < 0.05$). It was concluded that limited ROM was significantly correlated with the development of patellofemoral osteoarthritis after ACL reconstruction.

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●要旨

膝蓋腱をwoven polyesterで補強した前十字靭帯再建術後に発生した膝蓋大腿関節の関節症変化を評価し、関節症発生に影響を与える因子を検討した。対象は術前に膝蓋大腿関節の関節症変化やアライメント不良のない30例である。平均5.7年の調査時、22例は関節症変化がなく（正常群）、残り８例（26.6%）に軽度の関節症変化を（OA群）認めた。軽度の膝蓋大腿関節痛を正常群７例（31.8%）、OA群３例（37.5%）に認めた。明確な轢音は両群ともそれぞれ2例に認めた。術後のLysholm knee scoreは正常群平均97.0点、OA群95.0点であった。したがって、膝蓋大腿関節の関節症変化は膝蓋大腿関節症状の発現や自覚症状の悪化とは関連がなかった。前十字靭帯再建術後に発生する膝蓋大腿関節の関節症変化には、年齢、合併損傷、スポーツレベル、不安定性、可動域、筋力など種々の因子が関与する。今回の検討では、平均可動域と可動域制限の割合において、２群間に有意の差がみられた（$p<0.05$）。可動域制限は前十字靭帯再建術後に発生する膝蓋大腿関節の関節症変化に有意に関連すると結論された。

INTRODUCTION

The Patellar tendons is widely used for anterior cruciate ligament (ACL) reconstruction due to its tensile strength, capability to revascularize, and the good results obtained after long-term follow-up. However, postoperative complications[11]have been reported, together with potentially detrimental effects on the patellofemoral joint. Sachs et al. [13]reported that 66% of 36 patients had anterior knee pain or crepitance in a 1-year follow-up study. Aglietti et al.[1] found osteoarthritic changes in the patellofemoral joint in 30% of 44 patients in a 7-year follow-up; Johnson et al.[5] found similar changes in 37.6% of 87 patients in an 8-year follow-up. The etiology of osteoarthritic changes after ACL reconstruction is multifactorial, and is not yet completely understood.

The purpose of this study was to evaluate the osteoarthritic changes in the patellofemoral joint after ACL reconstruction, and to investigate which factors affected the incidence of these osteoarthritic changes.

MATERIALS AND METHODS

Patient population

Between 1986 and 1989, 66 patients underwent ACL reconstruction[10] using a patellar tendon augmented with woven polyester (Leeds-Keio mesh augmentation device[3]), and 34 of these were directly evaluated at a 5.7-year follow-up. Thirty of 34 showed no osteoarthritic changes or malalignment in the patellofemoral joint in

Table 1 Materials

Cases :	30 patients ; 30 knees
Sex:	male: 14 cases, female: 16 cases
Age:	a mean of 24.4 yrs (14-39 yrs)
Associated injury :	22 cases (73.3%)
Follow-up period:	a mean of 68.7 mos (60-91 mos)

preoperative radiographic examinations, and these 30 were subjects of this study (Table 1). There were 14 males and 16 females, with a mean age of 24.4 years (range: 14-39 years). The interval from injury to surgery ranged from 1 month to 144 months, with a mean of 15.5 months. Twenty-two of the patients (73.3%) had an associated injury : 16 had a meniscal tear, while 9 had a medial collateral ligament injury. The follow-up period ranged from 60 to 91 months, with a mean of 68.7 months.

Surgical procedure

One-third of the patellar tendon with bone blocks on both ends was harvested and tubed using absorbable sutures. Woven polyester was sutured tightly around the patellar tendon to make a composite graft with a diameter of 8 mm. The graft was passed through the tibial and femoral tunnels, and was fixed to the femur by 2 staples and to the tibia by a screw. After fixation of the graft, the knee was put through a full range of motion (ROM) to ensure proper tightness of the graft. Notch plasty was performed if the graft impinged in the intercondylar notch.

Rehabilitation

A hinged brace was applied immediately after the operation. On the 3rd postoperative day, ROM exercises with a limitation of a 20° extension on the CPM device and isometric quadriceps exercises were begun. Partial weight bearing was allowed at 3 weeks after surgery, increasing to full weight bearing at 8 weeks. Isotonic muscle exercises were started at 3 weeks, and isokinetic muscle exercises with ARIEL-CES (ARIEL DYNAMIC, Snadiego, Calfornia) at 180 deg/sec at 4 weeks postoperatively. The hinged brace was removed at 12 weeks, and sports were allowed at 16 weeks postoperatively.

Clinical and radiographic evaluation

Subjective results were assessed by pain or crepitance in the patellofemoral joint, and by the Lysholm knee scoring system.

Objective results included anterior knee laxity using a KT-1000 arthrometer measurement (Medmetric, Sandiego, Calfornia), ROM, and muscle strength measurements using an ARIEL-CES. KT-1000 arthrometer measurements for anterior knee laxity were performed at 20 ° knee flexion with 90 N force. Isokinetic muscle strength measurements were made with ARIEL-CES at 60 deg/sec.

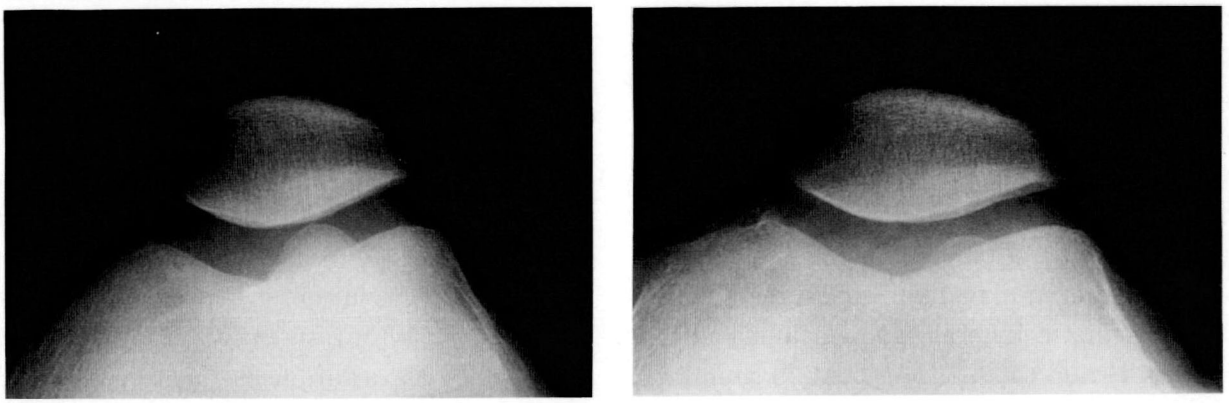
Radiographic evaluation for osteoarthritic changes in the patellofemoral joint were classified into 3 grades as follows; mild changes, involving formation of osteophytes without joint space narrowing; moderate changes, involving mild joint space narrowing; and severe changes, involving moderate or severe joint space narrowing (Fig. 1). According to radiological results, the 30 studied patients were divided into 2 groups; a normal group of those patients with a normal patellofemoral joint; and an OA group of the patients with osteoarthritic change.

The statistical analysis was performed using an analysis of variance and chi square test, and $p=0.05$ was accepted as the minimum level of significance.

RESULTS

Radiological results

Twenty-two of the 30 patients had no osteoarthritic changes in the patellofemoral joint at follow-up examination, and comprized the normal group. The other 8 patients (26.6%) had mild osteoarthritic changes with osteophytes in the lateral facet of the patella, and comprized OA group. None of the patients in this study had moderate or severe osteoarthritic changes.



a b

Fig. 1 Osteoarthritic changes in the patellofemoral joint.
a : No changes were observed before surgery.
b : Osteophyte formation was observed in the lateral facet of the patella at follow-up

Table 2 Postoperative Total LysholmScore

Normal group (N=22)	97.0±4.6 pts.
OA group (N=8)	95.0±7.0 pts.
Total (N=30)	96.4±5.3 pts.

Subjective results

Ten patients had mild patellofemoral pain when going up or down stairs, or when squatting, at follow-up. These symptoms were found in 7 patients of the normal group (31.8%), and in 3 of the OA group (37.5%). A definite crepitance in the patellofemoral joint was found in 2 patients of each group.

The postoperative total Lysholm knee score for the 30 patients ranged from 85 to100 pts., with a mean of 96.4 ± 5.3 pts.(Table 2). The mean total score was 97.0±4.6 pts. in the normal group, and 95.0±7.0 pts. in the OA group, with no significant difference between the 2 groups.

Objective results

Postoperative KT 1000 arthrometer measurements showed that the mean injured-to-uninjured difference in the anterior knee laxity was less in the OA group (0.8±3.1mm) than in the normal group (1.7±2.8 mm) (Table 3). Moreover, the percentage of patients who had decreased anterior knee laxity in the injured side compared with the uninjured side was higher in the OA group (62.5%) than in the normal group (31.8%). However, these differences were not statistically significant.

The mean ROM was 149.8±1.1°in the normal group, and 146.3±5.2°in the OA group, with a limitation in ROM of 10°or less observed in 4 patients (Table 4). The percentage of patients

Table 3 Postoperative KT-1000 Measurement

	Mean injured to uninjured differences	Percentage of cases with stiff knee*
Normal group	1.7±2.8 mm	7/22 (31.8%)
OA group	0.8±3.1 mm	5/8 (62.5%)
Total	1.5±2.8 mm	12/30 (40.0%)

* Percentage of cases with decreased anterior knee laxity in the injured side compared with the uninjured side

Table 4 Postoperative ROM

	ROM	Percentage of cases with limited ROM*
Normal group	149.8±1.1° **	1/22 (4.5%) **
OA group	146.3±5.2°	3/8 (37.5%)
Total	148.8±3.1°	4/30 (13.3%)

* Percentage of cases with decreased ROM in the injured side compared with the uninjured side, ** $p<0.05$

with a limitation in ROM was significantly higher in the OA group (37.5%) than in the normal group (4.5%).There were statistical differences in ROM as well as in the percentage of patients with a limitation in ROM between the 2 groups ($p<0.05$).

The mean isokinetic quadriceps muscle strength in the injured side was 87.6±19.2% of that in the uninjured side in the normal group, and 92.6±19.0% in the OA group (Table 5). The mean isokinetic hamstring muscle strength in the injured side was 96.1±10.4% in the normal group, and 105.3±10.1% in the OA group, with no significant difference between the 2 groups.

DISCUSSION

Many reports have pointed out that untreated ACL ruptures may lead to residual instability, which can frequently result in secondary damage to the patellofemoral joint such as chondromalacia or osteoarthritis[9]. Roth et al.[12] reported that osteoarthritic changes in the patellofemoral joint were observed in 37% of patients in preoperative radiographic examinations. Dorchak et al. reported that 66% of patients who had failed conservative treatment showed abnormal scintigraphic activity in the patella. In experimental studies using dogs, Marshall et al.[8] noted that macroscopic and histological examinations revealed formation of osteophytes in the joint in which the ACL was cut, and these changes became increasingly severe with time. They suggested that instability was one of the most important factors in the initiation and formation of osteophytes.

On the other hand, several investigators found development of osteoarthritic changes in the

Table 5 Postoperative Isokinetic Muscle Strength

	Quadriceps muscle	Hamstring muscle
Normal group	87.6±19.2%	96.1±10.4%
OA group	92.6±19.0%	105.3±10.1%
Total	88.9±19.0%	98.5±11.0%

Table 6 Factors Affecting the Incidence of Osteoarthritic Changes in the Patellofemoral Joint after ACL Reconstruction

Factors	Normal group (N=22)	OA group (N=8)	Significant differences
Age	23.0 yrs	28.1 yrs	-
Meniscal tears	54.5 %	50.0 %	-
Follow-up period	67.0 mos	73.3 mos	-
Athletic activity	13.6%	25.0%	-
KT-1000	1.7±2.6 mm	0.83±3.1 mm	-
ROM	149.8±1.1°	146.3±5.2°	+
Limited ROM	4.5%	37.5%	+
Quadriceps	87.6±19.2%	92.6±19.0%	-
Hamstring	96.1±10.4%	105.3±10.1%	-

patellofemoral joint after ACL reconstruction using the patellar tendon. Aglietti et al.[1] reported that 25% of 44 patients had mild osteoarthritic changes, and 5% had moderate changes, at follow-up; severe patellofemoral pain was found in 9%, and a definte crepitance in 20%.

In this study, mild osteoarthritic change such as osteophyte formation was found in 26.6% of the patients (OA group), but moderate or severe change was not found. Two patients had a definite crepitance in the OA group, but these symptoms were also found in 2 patients in the normal group. There was no significant difference in the mean total Lysholm knee score between the 2 groups. Therefore, osteoarthritic changes in the patellofemoral joint were not correlated with the incidence of patellofemoral symptoms or worse subjective results.

Osteoarthritic changes in the patellofemoral joint have been observed after ACL reconstruction using patellar tendon, as well as after reconstruction using hamstring tendons[4] or allografts[7]. Therefore, these changes were not a direct effect of the harvesting of the patellar tendon, but were rather due to other factors such as age, associated injury, level of sports activities, instability, ROM, and muscle strength. Sachs et al.[13] reported limitation in ROM, and in paticular in extension which were found to be correlated significantly with the incidence of patellofemoral osteoarthritis. They noted that limitation in ROM, which caused increased patellofemoral contact forces, may led to the patellofemoral osteoarthritis. They also described

how patellofemoral osteoarthritis caused decreased quadriceps muscle strength.

In this study, the limitation in ROM was also significantly related to the development of osteoarthritic changes, as shown in Table 6. However, the mean quadriceps muscle strength was higher in the OA group than in the normal group. Therefore, osteoarthritic changes were not the cause of decreased quadriceps muscle strength. Johnson et al.[6] found that patients with an ROM limitation of more than 10° often demonstrated patellofemoral problems and quadriceps weakness. It may be that the absence of quadriceps weakness in our OA group was because none of our patients had an ROM limitation of more than 10°.

Rehabilitation after ACL reconstruction plays an important role in the functional outcome of the knee. A limitation in ROM is usually due to the immobilization in a plaster cast and a prolonged rehabilitation programme.

In our series, we did not use plaster casts and performed the rehabilitation programme earlier than usual. However, full extension of the knee was not permitted until 2 weeks after surgery, and these protocols may have adversely affected recovery of postoperative ROM. Shelbourne et al.[14] suggested that the most effective method to prevent limitation in ROM was rehabilitation that did not limit motion and stressed active quadriceps control. More aggressive rehabilitation may be needed to prevent limitation in ROM, which can lead to incidence of patellofemoral osteoarthritis.

CONCLUSION

We evaluated the osteoarthrotic changes in the patellofemoral joint after ACL reconstruction using the patellar tendon augmented with woven polyester, and investigated the factors affecting the incidence of the osteoarthrotic changes.

1) Twenty-two of 30 patients had no osteoarthritic changes in the patellofemoral joint (normal group), and 8 patients (26.6%) had mild osteoarthritic changes (OA group).

2) Mild patellofemral pain was found in 31.8% of the normal group, and in 37.5% of the OA group. A definite crepitance was found in 2 patients in each group. The postoperative total Lysholm knee score was 97.0±4.6 points in the normal group, and 95.0±7.0 points in the OA group, with no significant difference between the 2 groups.

3) The mean postoperative injured-to-uninjured difference in KT 1000 arthrometer measurements was 1.7±2.8 mm in the normal group, and 0.8±3.1 mm in the OA group.

4) The mean ROM was 149.8±1.1° in the normal group and 146.3±5.2° in the OA group, and the percentage with an ROM limitation of 10° or less was 4.5% in the normal group, and 37.5% in the OA group, with significant difference in the mean ROM, and in the percentage of ROM limitation between the 2 groups (both $p < 0.05$).

5) The mean isokinetic quadriceps muscle strength of the injured side was 87.6±19.2% of that of the uninjured side in the normal group, and was 92.6±19.0% in the OA group. The mean isokinetic hamstring muscle strength of the injured side was 96.1±10.4% in the normal group, and 105.3±10.1% in the OA group.

6) It was concluded that limited ROM was significantly correlated with the development of patellofemoral osteoarthritis after ACL reconstruction.

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Arthroscopic Management of Osteochondritis Dissecans of the Knee

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●Abstract

It is well recognized that the knee joint is the most common site of osteochondritis dissecans(OCD) which are most often affected in the medial femoral condyle. Although there is still no clear etiology of OCD, mechanical process due to repetitive trauma or circulatory defect leading to osteonecrosis of subchondral bone have been postulated as the major causative factors.

The authors have experienced 25 knees of 21 patients who had OCD in one or both knees (11 in the medial femoral condyle, 12 in the lateral femoral condyle, 2 in the lateral tibial condyle and 2 in the patella) which underwent operative treatment arthroscopically from September 1983 and followed up them over 30 months.

It is characterized all cases developed in the lateral femoral condyle have associated with symptomatic torn discoid meniscus which underwent arthroscopic reshaping.

As a treatment method, we performed arthroscopic removal of loose fragments and trimming of crater in 15 cases, absorbable K-wire fixation in 3 cases and the rest were only observed after multiple drilling. As a result, we rated 4 cases as excellent, 14 cases as good, 5 cases as fair and 2 cases as poor according to the rating criteria of Hughston.

Our findings suggest strongly that OCD developed in the lateral femoral condyle is the result of abnormal shearing stress of lateral discoid meniscus and so we recommand arthroscopic reshaping of the symptomatic discoid meniscus as early as possible to protect the femoral condyle from abnormal shear stress.

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INTRODUCTION

Many papers have been written about osteochonritis dissecans (OCD) but the subject remains controversial. OCD is the most frequent cause of "loose bodies" in the articular cavity of the knee in young people. All prior reports have documented that the lateral aspect of MFC was the predominebt site of this lesion, but approximately 15 to 20% of all affected knees in the lateral femoral condyle.

Many different causes have been suggested including trauma[1,20], contact with the tibial spine[7,26], ischemia[6], abnormal ossification of the epiphyseal cartilage[3,5], heredity influences and generalized disorders such as multiple epiphyseal dysplasia and Frohlich's syndrome[22].

Although there is still no clear etiology of OCD, mechanical process due to repetitive trauma or circulatory defect leading to osteonecrosis of subchondral bone have been postulated as the major causative factors.

The purpose of this study is to report the clinical results of 25 knees/21 patients treated arthroscopically for OCD in the knee and present the characteristics of this scewed materials of which one half of cases of OCD developed in the lateral femoral condyle all of those were associated with the lateral discoid meniscus.

MATERIALS AND METHODS

This group consisted of 25 knees/21 patients treated for OCD arthroscopically. They included 13 males and 8 females. The ages ranged from 12 to 52 years (mean 21 years).

Patients were examined clinically for evidence of effusion, atrophy, condylar tenderness and audible clicks or clunks indicative of mechanical dysfunction at pre and postoperative time with the follow-up periods over 30 months.

Most of the patients, 23 of 25 knees had a presenting complaint of intermittent pain. In the majority of those in which the symptoms were intermittent and of long duration, occasional swelling in 19, locking in 15, click sound in 15, giving way in 14, wandering palpable mass in 12 and limited motion with extension block in 12 knees. Only 4 of the 25 knees had a history of trauma in this group.

The standard anteroposterior, lateral and tunnel view roentgenographs were available for all 25 knees and the location and the size of the lesions were measured roentgenographically. The product of these two findings was used as an estimate of the cross-sectional area. The contralateral knee was radiographed to determine bilateral involvement.

Magnetic Resonance Imaging were needed sometimes for more precise evaluation of the lesions which showed few or suspicious articular cartilage changes.

The entire joint were throughly examined by probing to rule out any associated pathologic conditions like a loose bodies, coexisting meniscus pathology, arthritic changes and chondromalacia. On the basis of the arthroscopic examination, the lesions were classified one of the following groups. 1) Intact lesions, 2) Lesions showing signs of early seperation, 3) Partially detached lesions and 4) craters with loose bodies(salvageable or unsalvageable). After the arthroscopic examination of joint, the location of the lesion was determined and classification was done. then the surgery was planned.

The time intervals from initial onset of symptoms to operation were listed in table 1. 10 knees were treated arthroscopically in 1 year after the onset of symptom, 2 knees in 1 to 2 years, 5 knees in 2 to 4 years, 8 knees over 4 years. Most of all cases in this series tended to have more chronic condition.

Table 1. Onset of Symptoms to the time of surgery

Months	No
0-2	4
3-6	3
7-12	3
13-24	2
25-48	5
>49	8

Table 2. Involved site

Site	No
Medial femoral condyle	11
Lateral femoral condyle	12
-Combined lesion in lateral tibial condyle	2
Patella	2

Table 3. Methods of Treatment

Method	No
Removal of loose body	16
Trephinning, Spongialization	11
Multiple drilling in situ	6
Drilling & pinning	3
Reshaping of discoid meniscus	12

8 patients had the lesion in right knee, 9 patients in left and 4 patients in both. The medial femoral condyle was affected in 11 knees, the lateral femoral condyle was affected in 12 knees, two of which presented bilateal lesions of femoral and tibial condyles and also patella undersurface was affected in both kneees of one patient (Talbe 2).

Most of the lesions in the weight-bearing area of the medial femoral condyle in the lateral view usually bordered by a line projecting from the posterior femoral shaft (Harding's line[13]) and intersecting by a line projecting from the femoral groove (Blumensaat's line). However in lateral condylar lesion, the portion posterior to the Harding's line was the usual site.

ARTHROSCOPIC TREATMENT

The operative procedure used in this series of patients were removal of loose bony fragments, and abrasion by trephenning or spongialization or drilling of the base of the crater.

16 knees were treated by removal of loose body, 11 by trephinning or spongialization, 6 by multiple drilling in situ, 3 by drilling & pinning and 12 cases with torn lateral meniscus by reshaping of discoid meniscus depending on the configuration and the site of ruptured portion (Table 3).

RESULTS

Mediopatellar plica was present in 23 knees

Table 4. Associated findings

Associated finding		No
Mediopatella plica		23
Synovitis with hypertrophy		21
Loose bodies		16
Pathologic meniscus		14
Medial meniscus rupture	2	
Lateral discoid rupture	12	
Villonodular synovitis		1

Table 5. Athroscopic grading system

Grade	Finding	No
1	Intact lesion	1
2	Early seperation	7
3	Lesion partially attached	3
4	Crater lesion with loose body	14
Total		25

Table 6. Rating criteria by J.C Hughston (1984)

Rating	Score(points)	Criteria
Excellent	4	No limitation of activity No symptoms Examination & radiographs normal
Good	3	Mild aching with strenous activity Examination normal Radiographs show healed defect or residual sclerosis
Fair	2	Mild aching and swelling with activity Examination normal Radiographs show flattening of condyle but normal joint space
Poor	1	Pain and swelling with mild acivity Tenderness Loss of 20 degrees of motion Zero to 2.5cm of thigh atrophy Radiographs show irregularity of condyle and narrowed joint space
Failure	0	Pain and swelling with no activity Tenderness Loss of motion of more than 20 degrees More than 2.5cm of thigh atrophy Radiographs show absent joint space

on arthroscopy, synovitis in 21 knees, loose bodies in 16 knees, pathologic meniscus in 14 knees including rupture of medial meniscus in 2 and rupture of lateral discoid meniscus in 12 knees and also villonodullar synovitis in 1 knee(Table 4).

On the bases of arthroscopic examination according to Guhl's arthroscopic grading system[12], 14 knees were classified as grade Ⅳ lesion, 1 knee in grade Ⅰ, 7 knees in grade Ⅱ and 3 knees in grade Ⅲ(table 5). In terms of size of the lesions, the lesions of 12 knees were above 15mm and below 30mm, 8 lesions were below 15mm, 5 lesions were above 30mm in diameter.

Table 7. Results of treatment

Results	No
Excellent	4
Good	14
Fair	5
Poor	2
Failure	0

Over one half of cases tended to have more chronic cases with multiple loose bodies than usual and demonstrated more serious lesions.

Evaluation of final results were based on the clinical, radiographic and subjective criteria of Hughston[14] (Table6 and Table7). Of the25 knees with adequate follow-up information, we rated the results as excellent in 4, good in 14, fair in 5 and poor in 2 knees but no failure was present.

CASE ILLUSTRATION

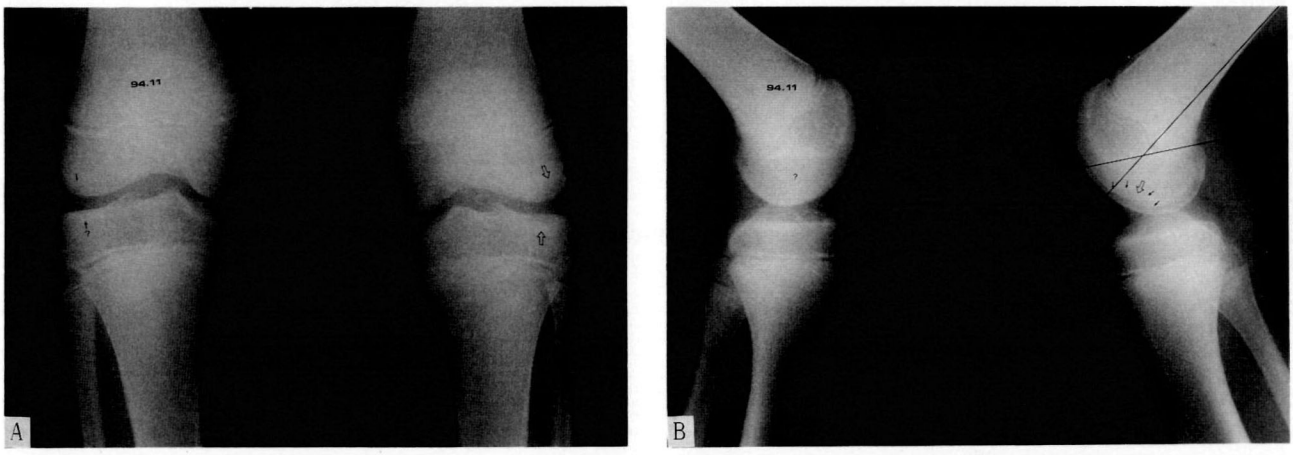
The following one case illustrate example of osteochondritis dissecans of lateral femoral condyle combined with lateral discoid meniscus tear bilateally.

Case. A 13-year-old boy have had a knee joint pain during 2 years after minor trauma and had osteochondral defect of lateral femoral condyle of both knee on simple radiographs(Fig.1-A & B) and focal, decreased signal intensities on weight bearing surface of both lateral femoral and tibial condyles on Magnetic Resonance Image (Fig.2-A & B).

During 3 months of the follow-up period with close observation, more progressive radiological changes were noticed on both femoral and tibial condyles bilaterally (Fig.3-A & B).

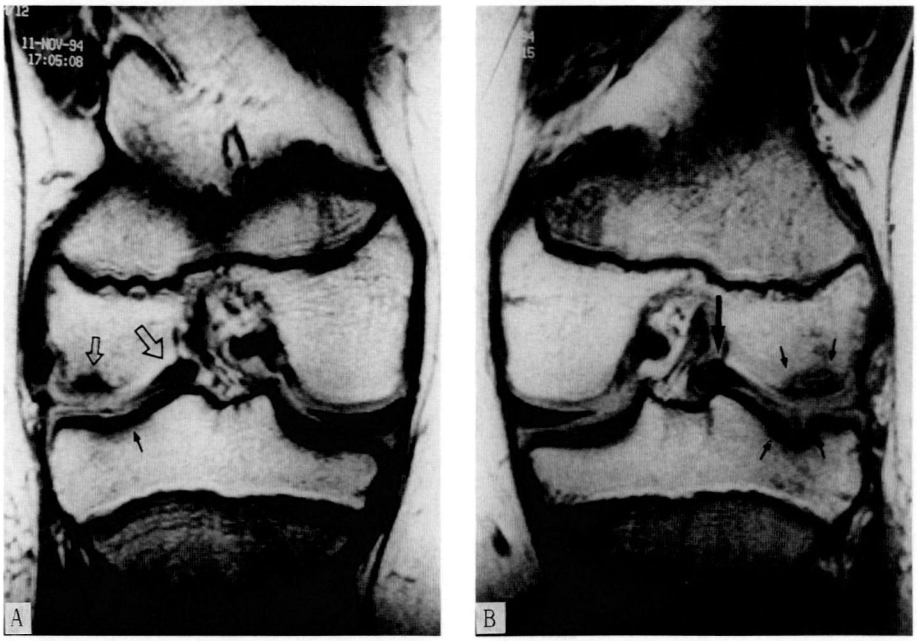
Arthroscopic examination of the both knees showed early partial seperation of the lesions and degeneration of the joint surface of the lateral tibial plateau and some elevation of the condylar surface of the femur and torn lateral discoid meniscus (Fig.4-A & B).

Treatment was reshaping by partial menis-



A B

Fig.1-A & B. Cystic radiolucent areas were evident in the lateral femoral condyles of both knee and same lesions were suspected in the lateral tibial plateaus of the both knee.



A B

Fig.2-A & B. Focal and decreased signal intensities of the weight-bearing surfaces of the lateral femoral and tibial condyles of both knee and displacement of the torn lateral discoid menisci on MRI finding.

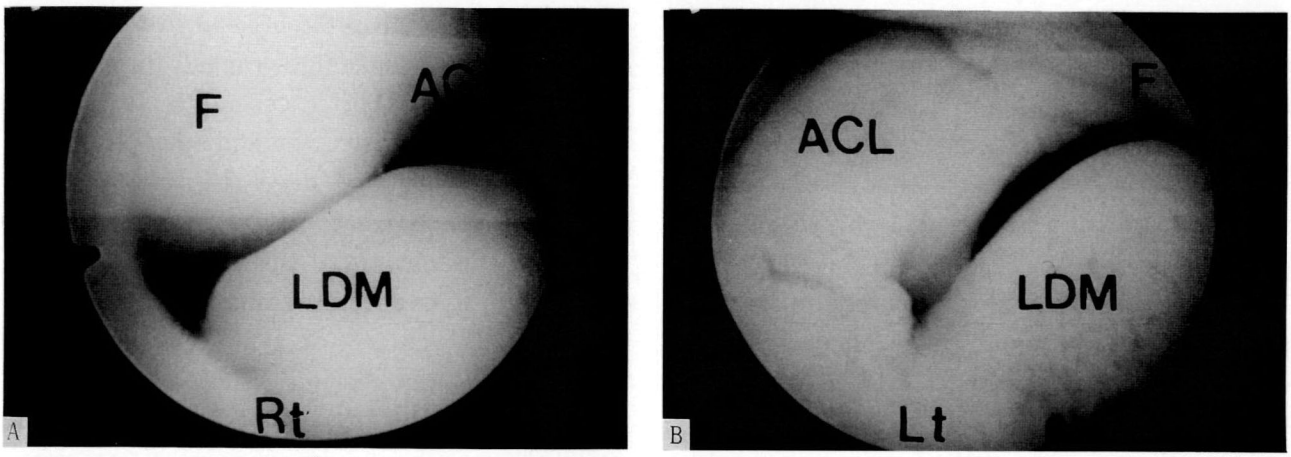
A B

Fig.3-A & B. Cystic radiolucent areas were more evident in the lateral femoral and tibial condyles of both knee after three months follow-up.

cectomies of torn discoid meniscus and multiple drilling of the fragment's bed and debridement of the irregular surface of the lesion.

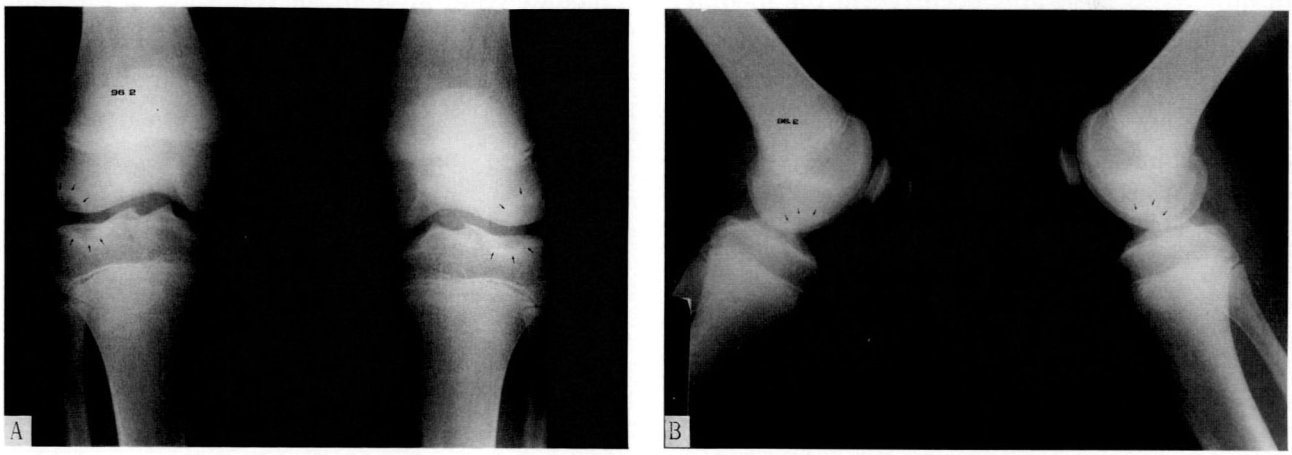
After operation nonweight bearing protection was recommanded for 3 weeks and followed by partial weight bearing with crutch for another two or three months.

At 13 months' follow-up, he has no pain and no limitation of joint motion and was rated as good result even though the simple radiograph showed more progressive change on both



A B

Fig.4-A & B. Arthroscopy shows the medial displacement of torn lateral discoid menisci of both knee.



A B

Fig.5-A & B. One year after arthroscopic treatment, residual radiolucent areas were visible but functional result was rated as good with full activities.

lateral femoral and tibia condyles (Fig.5-A & B).

DISCUSSION

Various theories about the etiology of osteochondritis dissecans have been suggested but none has been accepted universally. Trauma[1,20], ischemia[6], defects of ossification[3,5], genetic[22] causes have been discussed as possible etiological factors that vary depending on the specific joint involved and on the specific site within that joint[21].

Fairbank[7] and later Smillie[25,26] and proposed that repetitive impingement of the tibial spine of the lateral aspect of the medial femoral condyle during internal rotation of the tibia and concomitant ligament laxity are causative factor in osteochodritis dissecans. Aichroth[1] thought that the lesion is caused by an ununited subchondral fracture in association with

pathological patellofemoral contact. Mubarak and Carroll[19] noted that trauma is an unlikly cause since affected site are located at specific locations in the knee and not randomly, as would be expected with trauma. In our study, there was a histories of trauma only in 4 knees of the 25 knees.

Smillie[25] proposed a mechanism of stress fracture after subchondral ischemic necrosis by compression and shearing force through the torn meniscus.

Approximately 80% of the lesion occur in the medial femoral condyle and 15% of the lesion occur in the lateral femoral condyle of knee joint in reports of several authors[1,9,14,16]. However in our cases, 11 lesions occurred in the medial femoral condyle, 12 lesions in the lateral femoral condyle, 2 lesions in the patella. In one patient, he had four lesions of both femoral and tibial condyle bilaterally.

Aichroth[2] reported an associated osteochondritis dissecans of the lateral femoral condyle in seven knees of 62 discoid lateral meniscus of 52 children.

There were 12 torn lateral discoid meniscus combined with osteochondritis dissecans in the lateral femoral condyle and tears of medial meniscus in 2 knees in our cases. All of this cases had thick slab-type lateral discoid meniscus and most of them were ruptured at the multiple sites. patients in this series tended to have more chronic cases and more progressive lesions.

The outstanding suggestive etiological feature was found to be indirect injury to the joint surface with shearing stress in cases of OCD in the lateral femoral condyle.

Lesions affecting children those are lesions of juvenile osteochondritis dissecans in patients with open physes frequently heal. Green and Banks[10] used a cast or brace in an attempt to prevent fragmentation of the joint surface so that healing could progress and in their series of 14 patients whose ages ranged from 4 to 15 years old, they report excellent result. Linden[16] reported that children who had open physes did not have secondary degenerative change at an average 33 years. Lofgren[17] also noted spontaneous healing of the lesions in children. Cahill[4] proposed limitaiton of activities until the patient was free of symptoms as well as protected weight-bearing with use of splints or crutches. But the lesion of OCD affected in the lateral femoral condyly which were associated with discoid meniscus tended to have progressive change without any surgcal treatments.

The basic principle of operative treatment include restoration of the congruity of the joint surfaces, enhancement of local blood supply to the fragment or crater, rigid fixation of unstable fragments, and protected weight-bearing with motion of joint as soon as possible[23]. Accepted operative indication include symptomatic loose bodies, detachment that occurs during observation, predicted physeal closure within 6 to 12 months, established non-union of fragment, and symptomatic juvenile lesions despite adequate symptomatic treatment[14].

One of the problems in the treatment of advanced OCD is how to manage the condyle defect with crater. Various operative methods have been proposed by many authors:simple excision of fragment, multiple drilling, replacement, internal fixation for a loose, seperated fragment with use of pins[25] or Kirschner wire[15,18] or bone pegs[24], and replacement with use of allogeneic[8,18] and autogenous graft with AO screw fixation[27].

Arthroscopy is a valuable tool in the evaluation and treatment of osteochondritis dissecans of the knee. The advantage of arthroscopic management include lessened morbidity of patients, increased capability of discovering concomittent pathologic lesions

and accurate assessment of healing by direct visualization. In an early report, Guhl[11] reviwed the use of various arthroscopic procedures directed at preservation of the fragment and noted healing in 18 of 24 patients.

SUMMARY

25 knees of 21 patients with osteochondritis dissecans were evaluated and treated by arthroscopic means inluding drilling, pinning, trephinning, removal of loose fragments, and reshaping of the lateral discoid meniscus depending on the location, degree of separation and its size.

All cases of OCD in the lateral femoral condyle had thick slab-type discoid meniscus.

Our experience would suggest that the lateral discoid meniscus is the possible cause of OCD in the lateral femoral condyle of the knee and so we recommand arthroscopic reshaping of symtomatic discoid meniscus as early as possible to protect the femoral condyle from abnormal shear stress.

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Factors Affecting the Femoral Tunnel Enlargement after Arthroscopic ACL Reconstruction

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●Key words
ACL, Femoral tunnel, Arthroscopic reconstruction

●Abstract

Retrospectively total 39 patients were reviewed for the femoral tunnel measurements radiologically at one year post-operation. (27 patients received bone-patellar tendon-bone (BPB) autograft, 12 patients received bone-patellar tendon-bone autograft and Kennedy LAD-ligament augmentation device). The surgery was performed using an arthroscopic single and double incision technique. AP and lateral X-rays were obtained and the tunnels were measured by two independent observers using a digital caliper. The measurements were made at the widest part of the tunnel. Correction for magnification was performed by comparing the measured width of the interference screw used for fixation of the graft with its actual width. Statistical analysis was performed using a one-way analysis of variance (ANOVA) and t-test. The results were as follows.

1. Radiographic tunnel enlargement of the femoral side was average 2.42 mm (bone-patellar tendon-bone autograft : 2.36 mm, Kennedy-LAD and autograft : 2.56 mm) ($p>0.05$).

2. According to the position of the interference screw, the femoral tunnel enlargement were 2.25 mm in anatomical fixation, 2.40 mm in mid-tunnel fixation, 2.62 mm in outer-tunnel fixation ($p<0.05$).

3. The femoral tunnel enlargement according to the overall results (Clancy, 1982) were 2.39 mm in above good result group and 2.50 mm in below fair result group ($p>0.05$).

Tunnel enlargement of the femoral side was related to a distance between the femoral articular surface and the position of interference screw.

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INTRODUCTION

It has been well known that he management goal for the ACL injured patient is to prevent recurrent knee injury, while allowing the patient to return to the desired work and the level of sports participation. The cascade of events from ACL disruption to secondary injuries with meniscus tears to joint arthrosis is well known. Many complications occurred following ACL reconstruction such as anterior knee pain, graft failure, flexion difficulty, altered extensor mechanism, cyclops syndrome[8] and the radiologic tunnel enlargemnt[3].

Enlargement of bone tunnels has been noted as plain X-rays following ACL reconstruction (Fig.1). The cause of this widening is unclear but it has been hypothesized that it may be due to either mechanical or biological causes.

The purpose of this study is to determine if any differecne exist in the amount of enlargement of the femoral tunnel following arthroscopic ACL reconstruction with position of interference screw fixation and instability, and to find the other factors which affected result.

MATERIALS AND METHODS

Between November 1990 and October 1994, we reviewed the 39 patients after ACL reconstruction with interference screw fixation using arthroscopic technique. 27 patients received bone-patellar tendon-bone (BPB) autograft, and 12 patients received bone-patellar tendon-bone autograft and Kennedy-LAD. All patients were evaluated radiologically and clinically at one year after operation. The KT-1000 arthrometer examinations were performed by a single

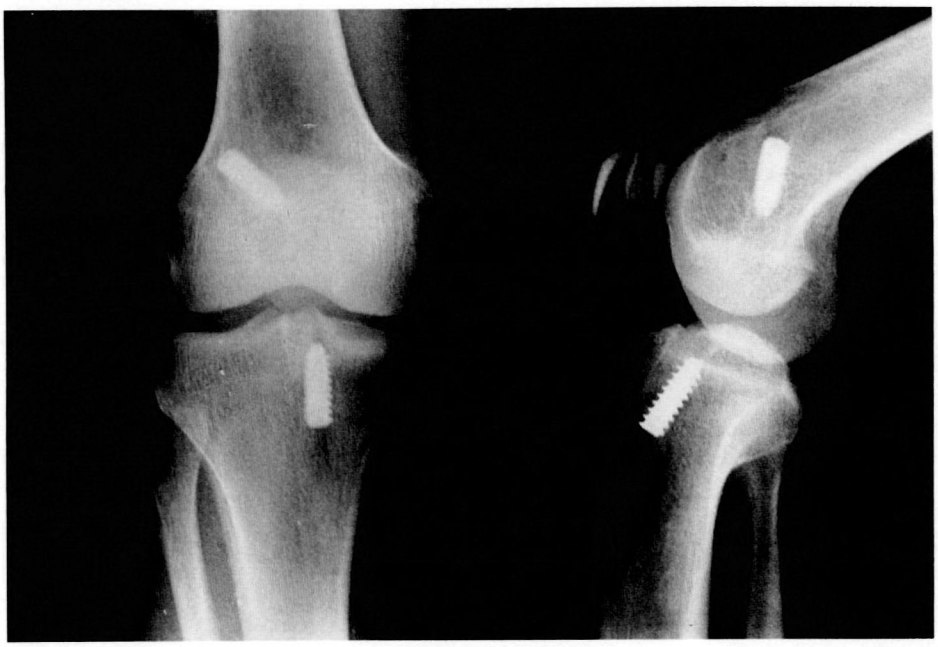

Fig. 1. Radiograph in bone-patellar tendon-bone autograft patient showing distal femoral tunnel enlargement

experienced examiner. We tested the KT-1000 arthrometer at 30 Newtons, We defined instability as more than 3 mm side to side difference. The Clancy evaluation[2] was completed for all patients. The scoring system has subjective, objective and functional components (Table 1). Statistical analysis was performed using a one-way analysis of variance (ANOVA) and t-test.

There was 35 men & 4 women. Most of them were injured by sports. Associated injuries were 10 cases of medial meniscus tear, 7 lateral meniscus tear, 2 MCL rupture, 1 LCL rupture and 2 PCL rupture and isolated ACL injury was 22 cases (Table 2).

Measurements of tunnel size

The widest femoral tunnel among the sclerotic margin measured in AP & lateral X-ray of the knee joint. The diameters of the interference screw was also measured to calculate the radiologic magnification. They were measured by an independent examiner &

Table 1. The Criteria of Overall Results by Clancy

Excellent
1. Full return to recreation, competitive sports or heavy labor with no or rare pain
2. No episode of instability or effusion
3. Drawer test : absent or trace

Good
1. Full return to recreation, competitive sports or manual labor with only occasional pain with strenuous activities and none with activities of daily living
2. No episodes of instability or effusion
3. Drawer test : 1+ or less

Fair
1. Significant but not disabling pain with sports or strenuous activities, but rare pain with activities of daily living
2. No episodes of instability or effusion
3. Drawer test : 1+ or less

Failure
1. Return of episodes of instability significant
2. Persistent effusion
3. Drawer test : 2+ more

Table 2. Associated Injuries

Associated Injuries	No.
Lateral meniscus tear	7
Medial meniscus tear	10
MCL rupture	2
LCL rupture	1
PCL rupture	2
Femoral condyle fracture	1
Tibial condyle fracture	1

*MCL : Medial collateral ligament,
LCL : Lateral collateral ligament
PCL : Posterior cruciate ligament

blinded measurement. Data were retrieved from the operative reports and medical records, including the size of the interference screw and size of the tibial drill bit used for tunnel reaming. The exact diameter of the tunnel could be calculated from the radiographs and compared with the known diameter. The calculation of the exact tunnel diameter was as followed.

$$\textit{Actual tunnel size} = \textit{Radiologic measured tunnel diameter} \times \frac{\textit{Actual screw diameter}}{\textit{Measured screw diameter}}$$

The position of interference screw fixation

The position of interference screw fixation classified as Fig. 2. The position 1 was located on the medial one-third in the lateral femoral condyle, position 2, middle one-third and position 3, the lateral one-third in the lateral femoral condyle.

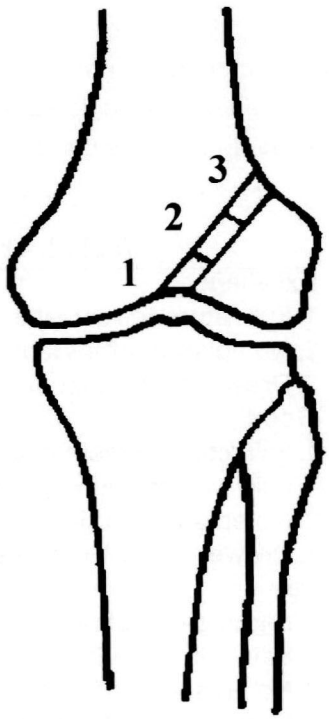

Fig.2 Position of interference screw fixation in femoral tunnel

RESULTS

All bone plugs appeared to have healed radiographically within the femoral tunnel. The mean increase in tunnel size in the plain X-ray was 2.42 mm (0.2 mm to 5.10 mm). The tunnel size in the BPB autograft group increased an average of 2.36 mm and in the Kennedy LAD group they increased an average of 2.56 mm (Table 3). There was no significant difference between these two groups statistically.

With relation to the tunnel size and position of interference screw fixation, position 1 group increased as average of 2.25 mm, position 2, 2.40 mm and position 3, 2.62 mm (Table 4). There was significant difference among these groups

Table 3. Enlargement in Femoral tunnel Size and Graft Material (Range, mm)

	Patellar Tendon Autograft	Kennedy-LAD	Total
Tunnel Enlargement	2.36 (0.2～4.9)	2.56 (0.5～5.1)	2.42(0.2～5.1)

P＞0.05

Table 4. Enlargement in Femoral tunnel Size and Position of Interference Screw Fixation(mm)

	Position 1	Position 2	Position 3
Tunnel Enlargement	2.25	2.40	2.62

P＜0.05

Table 5. Enlargement in Femoral tunnel Size and Clancy Evaluation (mm)

	Excellent	Good	Fair	Fail
Tunnel Enlargement	2.33	2.40	2.57	2.45

P>0.05

statistically.

Combined injury group increased an average of 2.38 mm and isolated injury group increased an average of 2.45 mm. There was no significant difference statistically.

The meniscectomy group increased an average of 2.24 mm. Saved meniscus group increased an average of 2.48 mm. There was no significant difference statistically, too.

The patients with greater than 1 standard deviation of radiographic tunnel enlargement were compared with those of the overall group. The 3 cases were in this category. But all were no instability and good or excellent result. Therefore, there were not correlated between the stability of the reconstructed knee and the tunnel enlargement.

The clinical results of the Clancy evaluation with greater than good result with 31 cases were 2.39 mm tunnel enlargement and others were 8 cases with 2.50 mm tunnel enlargement. No correlation was found between increased tunnel size and clinical outcome as determined by the Clancy evaluation (Table 5).

In our study, the position of interference screw fixation would rather effect on the femoral enlargement than the kinds of graft material, stability and clinical outcome.

DISCUSSION

The concept of reconstruction of the ACL was introduced by Hey Groves[6] in 1917, Since then, numerous procedures have proposed to repair or reconstruct the ACL. The importance of restoring functional stability to the knee after rupture of the ACL has become more apparent. Intraarticular reconstruction using a biologic substitute is a popular method of achieving restabilization.

The patellar tendon with its bony origin and insertion sites has been shown to be acceptable graft biomechanically and clinically. Others have advocated the use of other autogenous tissue such as the semitendinosus tendon, fascia lata and iliotivial tract as a graft. However, the use of autogenous tissue graft has a certain risk and morbidity. Patellar tendon ruptures and patellar fractures[16] have been reported as a result of using this type of autograft for reconstruction. Donor site morbidity can be seen in the form of tendinitis and the patellofemoral pain after autogenous bone-patellar tendon-bone ACL reconstructions. In addition, a recent article by Limbird et al.[10] cautions against the use of the semitendinosus tendon as a graft because of the importance of these muscles in dynamic joint control in ACL deficient knees. One advantage of allogenic tissue is that it can be used in patients who have failed a previous autogenous patellar tendon reconstruction. Another advantage is in patients who have patella baja, where the consequent available tendon is too short to span the joint cavity.

Many complications occurred following ACL reconstruction such as anterior knee pain, graft failure, flexion difficulty, altered extensor mechanism, cyclops syndrome[8] and the radiologic tunnel enlargement[3].

Enlargement of bone tunnels has been noted as plain x-rays. Many authors[1,9,11,12,14] reported observing the gradual increase in size of the bone tunnels in ACL replacements performed with achilles tendon graft. The cause of this widening is unclear but it has been hypothesized that it may be due to either mechanical or biological causes. Mechanical causes included stress shielding proximal to the interference screw resulting in resorption, circumferential bone necrosis during drilling and motion of grafted bone plugs. Biologic causes included immune response, graft rejection by synovium and methods of graft sterilization.

As the normal knee is flexed from 0°to 140°, the grafted ACL rotates approximately 100° about its femoral attachment and 40°about its tibial attachment. Graft used to reconstruct the ACL must accommodate this motion if normal knee kinematics are to be restored. Although they ultimately achieve biologic fixation at the tunnel orifice, initially they are fixed only at the ends and hence rotate freely within the tunnel. Thus, the edges of the tunnels may subject the grafts to contact forces and abrasion as the knee flexes and extends[3,5]. Therefore Ishibashi et al, [7] showed anatomical proximal fixation closed to the knee joint margin, resulted in the most stable reconstructed knee, with increasing instability as the level of fixation moved away from the tibial plateau. Schulte et al.[15] reported that patients with anatomical fixation didn't have any evidence of increased femoral tunnel size regardless kinds of graft material and the mechanical cause as a synovial fluid was more important than biologic cause as kinds of graft material in the radiologic tunnel enlargement. Fahey and Indelicato[3] reported that significant greater tibial tunnel enlargement were found in the group of non-irradiated BPB allograft compared with the group of the BPB autograft, but there was no correlation between radiologic tunnel enlargement and clinical outcome. Our current study provided that the tunnel enlargement was related to a distance between the articular surface and the position of interference screw. This is a function of a location of the bone plugs in relation to the natural insertion sites.

Other possible explanation of the radiologic tunnel enlargement is unrecognized rejection from an immune response. Several animal studies of fresh-frozen and freeze-dried ACL replacements revealed no histologic evidence of rejection for inflammation. Friedlander et al [4], and Rodrigo et al[13], have reported humoral and cell-mediated immune responses in animal. Several authors have noted intraarticular reactions to allograft ACL replacements with freeze-dried, ethylene oxide sterilized tissue. They likewise concluded that ethylene-oxide by-products were probably responsible. Our study had some limitation about kinds of graft because our cases didn't have an allograft reconstruction. But we found that the synthetic graft didn't affect the tunnel enlargement so far.

Another possible explanations could include simple resorption of the proximal tunnel bone. It is likely that drilling causes some area of circumferential necrosis, Along these same lines the area of tunnel proximal to the interference screw and bone plug may undergo stress shielding and subsequent resorption alone or in combination with resorption alone or in combination with resorption of a necrotic rim from drilling.

Other factors included as on affecting femoral tunnel size were the position of tunnel, diameter of tunnel, loads of the graft material.

SUMMARY

In our study, the position of interference screw fixation would rather effect on the

femoral enlargement than kinds of graft material, stability and clinical outcome. So we concluded that femoral tunnel enlargement following arthroscopic ACL recontruction is related to the mechanical effect rather than the properties of grafts and the clinical results.

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Role of Graft Tension in Tibial Tunnel Placement

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Kwon Ick Ha
Tae Hoon Kim

●Abstract

This study was designed to define the role of graft tension in placing tibial tunnel without graft impingement by the intercondylar roof. The relationship of the ACL to the intercondylar roof was studied in eighteen cases of chronic ACL insufficiency using plain X-ray assessment. An attempt was made to predict the amount of tension that may need to prevent impingement on an eccentrically placed tibial tunnel (5 mm anterior and medial to the center of the ACL insertion). Tension was loaded on the graft with a tensioner and radiograph was taken at an increment of 10 Newton loads from 10 to 60 Newtons. With a tension load of 50 Newtons, the main bulk of graft as well as tibial tunnel outlet became free of impingement without notchplasty. We believe this study demonstrates that proper graft tension is just as important, if not more, as the tunnel position.

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Introduction

The indications for perfoming roof plasty in ACL deficient knee have not been agreed upon. This may be due in part to the lack of consensus on the optimal location for placing the tibial tunnel. Placement variation of the tibial tunnel in the saggital plane produced different degrees of roof impingement. To minimize the adverse effect of notch plasty, posterior placement of tibial tunnel has recently been recommended by some authors. Many of these papers deal with the placement of tibial tunnel without mentioning graft tension force in regards to the impingement syndrome. The origin of ACL is free from impingement as long as the normal tension of ACL is maintained. But once ACL loses its tension, like chronic ACL insufficiency, anterior displacement of the tibia occurs in extended position which causes the impingement phenomena.

The purpose of our study is to check the amount of graff tension required to maintain normal tibio-femoral relationship when the graft impingement can be minimized.

Materials

Between October 1994 and December 1995 the first author performed static full extension lateral radiographs on eighteen knees with chronic anterior cruciate ligament insufficiency after ACL reconstruction. This study included thirteen males and five females with ages ranging from sixteen to fifty-three, mean age of thirty-two. The minimal interval between injury and initial evaluation was eight weeks. Diagnosis of ACL insufficiency was made on positive findings in Lachman test, anterior drawer test and a pivot shift sign clinically, and was confirmed during ACL reconstruction surgery. Roentgenography was peformed on twenty knees without any evidence of instability as a healthy control.

Method of X-ray Measurement

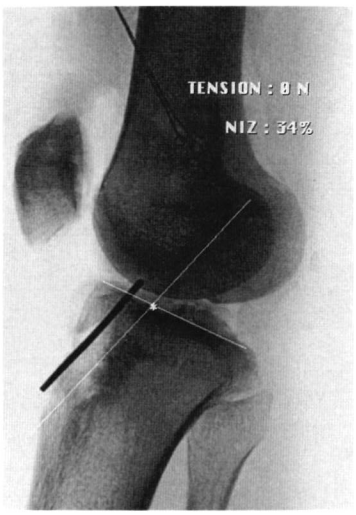
On lateral roentgenogram of the fully extended knee, two lines were drawn to estimate anterior translation of the tibia. The radiographic landmarks included intercondylar roof and tibial joint line. Anterior portion of the intersecting point of the tibial plateau and Blumensaat's line was defined as notch impingement zone (NIZ), which represents the amount of anterior displacement of tibia as well as the range of notch impingement. Notch impingement zone was expressed as relative length (NIZ %) compared to the width of tibial joint line. NIZ was evaluated after 50 Newtons of tension was loaded on the graft.

Results

Notch impingement zone was 33.0% in ACL insufficient knees and 25.0% ($p=0.0000$) after reconstruction. In normal knees the NIZ was 25.6% ($p=0.0000$) and 50 Newtons of graft loading forces were required to reduce the NIZ within normal limits. By means of graft tension loading, tibial tunnel moved posterior to the intercondylar notch. The total length of posterior movement at 50 Newtons of graff force was 8% of the length of the joint line.

Case presentation

A32 year old male suffering from anterior instability was operated on for anterior cruciate ligament reconstruction. Lateral roentgenogram was taken at an increment of ten Newton loads from 0 to 60 Newtons with the knee in full extended position. K-wire marked on the figures



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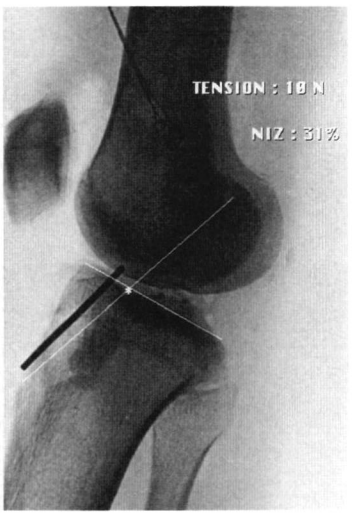

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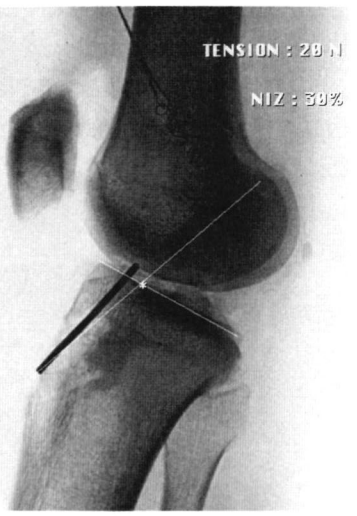

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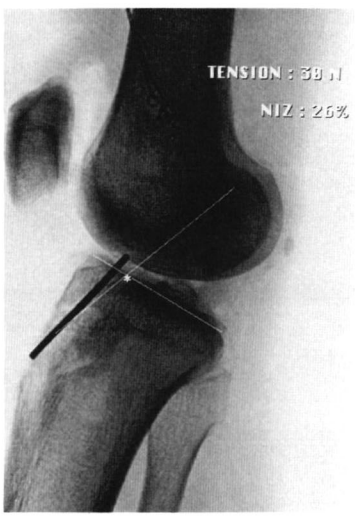

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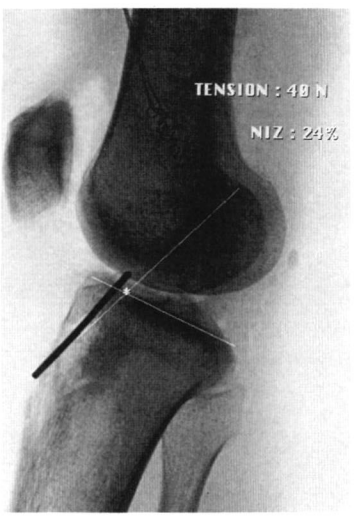

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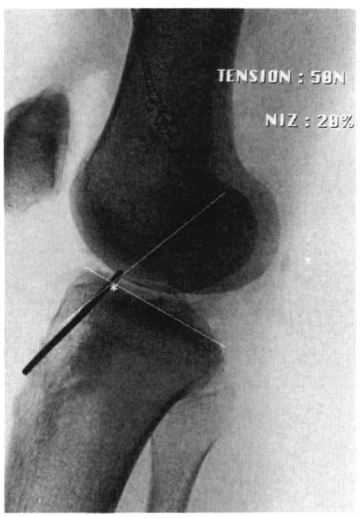

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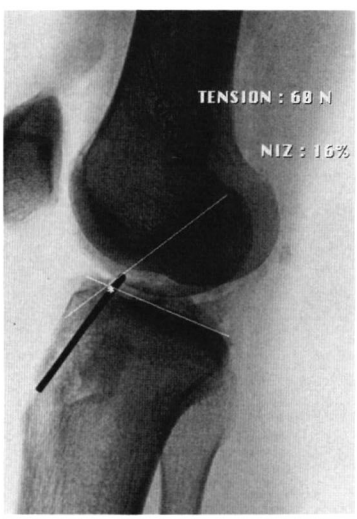

g

Fig.1 a,b,c,d,e,f,g ;
K-wires on the figures denotes the anterior margin of the tibial tunnel. With increased tension load, tibial tunnel moved posteriorly.
NIZ became normalized from the tension of 40 Newtons and the eccentric tibial tunnel also became free of impingement.

denotes the anterior margin of the tibial tunnel. With increased tension load, tibial tunnel moved posteriorly. At 50 Newtons of graft load, the NIZ was reduced within normal range of 25% (Fig.1a,b,c,d,e,f,g,h,& Fig.2a,b).

Discussion

The recommended placement of the tibial tunnel during ACL reconstruction has changed

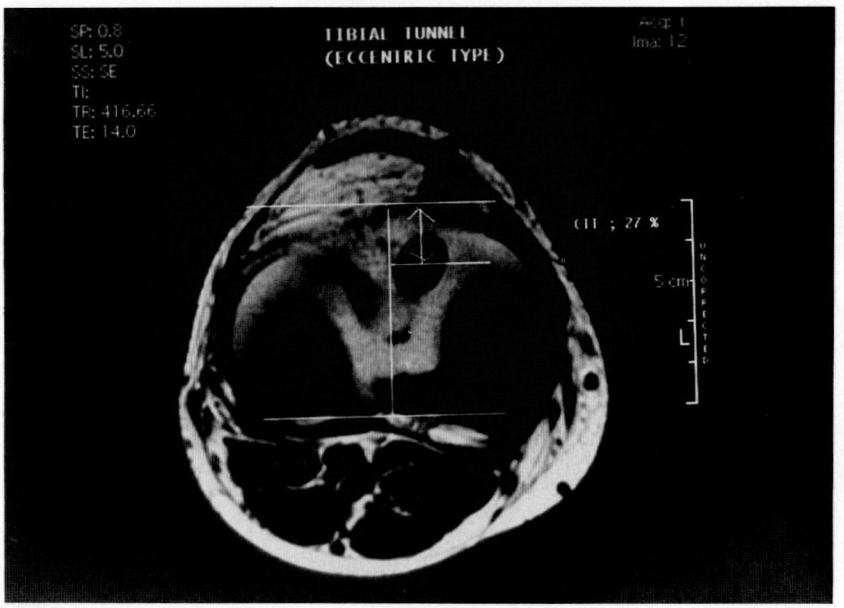

Fig.2a : In axial view, center of tibial tunnel is located at the eccentric anteromedial portion of tibial joint surface.

Fig.2b : Postoperative MRI shows reconstructed graft with homogeneous low signal density which is free from impingement.

over the years. Clancy et. al., in 1982, recommended eccentric tibial tunnel placement centered 5 mm anterior and medial to the "anatomic" ACL center[3]. O'Brien et. al., in 1987, demonstrated that anterior tibial attachment site was biomechanically more efficient. This decreased the load on the graft during the revascularization and remodeling phases and allowed the ligament to function more efficiently after maturation, thereby increasing its chance of survival[5]. Penner et. al., 1988 performed cadaveric study and revealed that ideal positioning of tibial tunnel was anteromedial to the ACL tibial insertional area for isometric positioning of ACL graft[6].

Yaru et. al., 1992 performed cadaveric study and reported that optimum placement of the tibial hole should be at the insertion of the anterior medial fibers of the anterior cruciate ligament. Posterior placement of the graft resulted in a change in attachment site distance of greater than 2 mm with a range of motion from 0° to 90° in all specimens tested. However in 1990, Howell et. al., studied impingement of the anteriorly positioned ACL graft by magnetic resonance imaging. He recommended that positioning of the center of the tibial tunnel should be 2-3 mm posterior to the center of the ACL insertion for prevention of roof impingement[2]. Many other authors also recommended posterior positioning of the center of the tibial tunnel in ACL reconstruction[3,4,7]. In normal ACL, anterior bundles provided all of the anterior restraining action at 30 ° knee flexion and developed much higher moduli than the posterior bundles[1]. There was no specific mention of graft tension graft tension and anterior tibial displacement. In the case of load application in ACL substitute, the impingement zone could be decreased up to an average of 8% of the length of tibial joint line. In other words, we could place the tibial tunnel more anteriorly in graft tension loaded state than unloaded without the risk of impingement.

Littel is known about the optimal amount of load on an ACL graft. It would be determined by the biomechanical properties of each graft substitute. A graft with proper stiffness, strength and length would be a good substance for tension loading.

In our study 50 Newtons of graft force was required to attain normal tibiofemoral relationship. We could suggest that an ideal graft for tension loading technique should endure the initial graft loading of 50 Newtons to eliminate notch impingement as well as anterior instability.

Conclusion

The relative position between intercondylar roof and tibial tunnel could be affected by the tension of the ACL substitute itself. More studies should be done on the role of tension in ACL substitutes.

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Arthroscopic Versus Open Acromioplasty for Impingement Syndrome and Partial Thickness Rotator Cuff Tear

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●Key words
Arthroscopiy, Impingement syndrome, Shoulder

●Abstract
We evaluate the results after the surgery for impingement syndromes and partial thickness rotator cuff tears with an average follow-up period of 15 months. One group (group I) of 43 patients, 46 cases underwent an arthroscopic subacromial decompression. The other comparable group(group II) of 10 patients, 11 cases underwent an open acromioplasty. The average age at operation was 48 years old. Arthroscopic subacromial decompression achieved slightly better pain relief, the range of the active forward flexion, function, strength and the overall score with improvement from the preoperative condition than open acromioplasty. The patient's satisfaction was better in group II as well. Using the UCLA Shoulder Rating Scale, 89% in group I and 82% in group II had a good or excellent results. Preservation of the origin of the deltoid during an arthroscopic acromioplasty reduced the postoperative morbidity and made it possible to start rehabilitation sooner and achieve the better and more predictable results.

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Impingement syndrome is one of the most common cause of pain in the anterior aspect of shoulder. The treatment of rotator cuff pathology has continuously evolved since Codman[1] first described. Neer[8] described three stages in the development of impingement: stage I, the reversible stage, in which edema and hemorrage predominate ; stage II, an irreversible state in which tendinitis and fibrosis predominate; and stage III, characterized by significant tendon degeneration and tearing. After Neer's work[7] in 1972 clarified the efficacy of the anterior acromioplasty, it is known to be an effective surgical treatment for subacromial impingement syndrome and rotator cuff tear in those patients who do not responded to conservative treatment. But it is difficult to see the rotator cuff in its entirety unless a complete bursectomy and extensive detachment of the deltoid origin are inevitable, and then only tears in the bursal side of torn rotator cuff can be seen during an open acromioplasty. If the deltoid origin is released to expose the anterolateral corner of the acromion and subacromial space, meticulous repair are needed. Any weakening of the deltoid mechanism will prolong the postoperative morbidity or impair the final functional resulf. An arthroscopic acromioplasty can eliminate these problems. With this procedure, both the glenohumeral joint and the subacromial space can be accessible without damage to the deltoid. So far, arthroscopic subacromial decompression has become an accepted treatment for patients with impingement syndrome, even though its use for full thickness rotator cuff tears continues to be controversial. We reviewed the result of arthroscopic subacromial decompression and open acromioplasty to evaluate the efficacy of arthroscopic acromioplasty.

Materials and Methods

A restrospective review was performed on fifty three patients, fifty seven cases who had undergone either an arthroscopic or open acromioplasty at the Shoulder Clinic in Kyung Hee University Hospital from January 1994 through June 1995. All of them had refractory impingement syndrome or partial thickness rotator cuff tear involved less than 50% thickness and less than 1cm. All patients underwent subacromial decompression by the same surgeon (Y.G.R.) Forty six cases were included in arthroscopic group (group I), and eleven cases were included in open group (group II). There average age was 48 years (range 18-73) and the man/woman ratio was 1. 3. There were thirty four right shoulders, twenty three left shoulders, and four in bilaterally. The dominant extremity was involved in sixty percents.

The average duration of symptoms before the acromioplasty was thirty four months. Among these patients, thirty three had symptoms within one year. Most of them had typical anterior shoulder pain, pain with lying on the affected shoulder, subacromial crepitus, subtle loss of range of active motion.

The diagnosis of impingement syndrome was based on the following findings; a history of pain in the shoulder, aggravated by overhead motion of the affected arm, and diminished function of the shoulder, combined with a positive impingement sign. Pain was preoperatively documented with no, mild, moderate and severe. Twenty nine cases in group I and seven in group II had severe pain, and seventeen in group I and four in group II complained moderate pain. Pain was scored average 2.8 ranged from 1 to 6 in group I and average 2.3 ranged 1 to 4 in group II by the

UCLA system. Preoperative function was evaluated in all patients and scored good, mild limited, moderate limited and markedly limited. Twenty two cases in group I and three in group had moderate limitation of activity of daily living. Twenty four in group I and eight in group II had a markedly limited. Shoulder function was scored average 3.4 ranged 1 to 6 in group I an average 2.8 ranged 1 to 6 in group II. Active flexion at the scapular plane was 105 degrees (range 60-180 degrees) due to moderate to severe anterior shoulder pain and active external rotation at the side was 32 degrees (range 0-90 degrees) and some of them complainted the weakness with abduction at the scapular plane.

An impingement sign was performed preoperatively on all fifty three patients. To demonstrate Neer sign, the examiner maximally forward flexes the patient's shoulder with one hand and exerts downward pressure on the acromion with the other hand. Thirty seven patients in group I and all of group II had a positive Neer sign. The pateints were also tested Hawkins sign for impingement of the rotator cuff against the coracoacromial ligament. The examiner places the patient's shoulder in 90 degrees of abduction at the sagittal plane and then passively internally rotates it. Thirty five patients in group I and all of group II had a positive Hawkins sign. Thirty six patients in group I and all of group II had a painful crepitus at the anterolateral corner of the acromion with rotating the arm, so called "a positive abrasion sign".

Radiographs were checked for all patients; true shoulder anteroposterior view, caudal 30 degrees view, supraspinatus outlet view and axillary view. A characteristic spur on the anterior acromial lip, the coracoacromial ligament, and occasionally spurs on the undersurface of the acromioclavicular joint. Preoperative radiographs of the soulder showed eight patients with the flat type of the acromion, twenty two with the curved, and sixteen with hooked in group I. In the group II, curved type showed in seven patients and hooked in four.

Operation

Arthroscopic subacromial decompression was done under the general anesthesia in nineteen patients and the interscalene block in twenty seven patients. Open acromioplasty was done under the general anesthesia in seven patients and the interscalene block in four patients. All of them underwent the operation with the beach chair position. Arthroscopic subacromial decompression was performed in five patients among the group I on the base of the out-patient clinic. It took average one hour and fifteen minutes for arthroscopic subacromial decompression, and average one hour and forty five minutes in the open acromioplasty.

Surgical techniques

Open

Open acromioplasty was performed in beach chiar position. An incision 5cm long over the deltoid with Langer's line from the edge of lateral margin of the acromion to superolateral side of the coracoid process was made. A deltoid splitting incision was created through the anterior raphe using a electocautery. The anteroinferior acromion was excised along with the attached coracoacromial ligament using a small osteotome and flattened the undersurface of the anterior acromion using a motorized burr. The bursectomy was done after the bursal side of the rotator cuff is examined. After standard acromioplasty was performed, the detached deltoid to the superior acromion was

reattached with utilizing the unabsorbable sutures passed through the bone of the anterior acromion.

Arthroscopic

Arthroscopic acromioplasty was performed in same position. Arthroscopy of the glenohumeral joint was routinely performed, followed by a standard arthroscopic acromioplasty, while viewing through a posterior portal and resecting through a lateral portal. After the inflamed and thickened subacromial bursa was shaved, electrocautery was used to release the coracoacromial ligament from the lateral to medial along the undersurface of the acromion. The anterior one third of the undersurface of the acromion was then removed with either a shaver or burr in the lateral portal from anterior to posterior and from lateral to medial.

Postoperative rehabilization

Patients were begun on passive range of motion exercises immediately in the post-operative period; 1) forward flexion at the scapular plane, 2) external rotation at the side, 3) cross body adduction, and 4) internal rotation at the back. Once a patient achieved full range of motion, the patient is allowed to strengthening exercises for the deltoid, the supraspinatus, the infraspinatus and the subscapularis if patient feel comfortable after three weeks postoperatively. At this time, most patients had returned to work and had recommanded the activity of daily living at the below level of the shoulder.

Results

All patients returned for follow-up examination and clinically reviewed with the UCLA score at 10 to 27 months postoperatively averaged 18.5 months. In group Ⅰ, postoperative scores for pain increased average 8.9 points ranged 6-10 points from average 2.8 points ranged 1-6 points in preoperatively. In group Ⅱ, postoperative scores for pain increased average 7.8 point ranged 2-10 points from average preoperative 2.3 points ranged 1-4 points.

The scores for function improved from 3.4 points to 9.1 points (range, 8-10) in the group Ⅰ, while the group Ⅱ improved from 2.8 points to 7.8 points (range, 2-10). At the last follow up, the active forward flexion at the scapular plane was 167 degrees in the group Ⅰ, and 163 degrees in the group Ⅱ.

The scores for the range of motion improved from 2.7 points to 4.9 points in the group Ⅰ, and improved from 3.6 points to 4.5 points in the group Ⅱ.

There were four failure, and three were in the group Ⅰ, one in group Ⅱ.

One patient who was in worker's compensation and had an impingement syndrome combined with stiff shoulder after greater tuberosity fracture obtained only 22 points post-arthroscopic subacromial decompression and capsular release in comparing with preoperative 10 points. This patient still complained a moderate pain and was unsatisfied with the latest result even though pain and function score increased 6 points from preoperative 2 points and score for range of motion improved 5 points from 2 points. Two patients who had had partial thickness rotator cuff tear with diabetes mellitus had fair results. One of these underwent the arthroscopic subacromial decompression, and another patient underwent the open acromioplasty. The first patient had 21 points of final score in comparing with preoperative 14 points. The score for pain improved 8 points from 4 points even though the range of motion and function was unsatisfied. The score for function and for range of motion was 4 points each other, while the preoperative function and range of motion

score was two and three points. The second patient had combined with complete biceps rupture and arthrodesis after arthroscopic resection of the biceps was performed simultaneously at the open acromioplasty. He had a persistent pain (pain score; 4) and was dissatisfied with the surgical procedure, even though postoperative range of motion and function was 8 points and 5 points each other. But the final score of this patient was 22 points, while the preoperative score was 13 points. The other had a partial thickness rotator cuff tear with partial rupture of the biceps tendon involved less than 50% thickness, and underwent arthroscopic subacromial decompression. His final score was 22 points from preoperative 10 points and was dissatisfied. He gained 5 points from preoperative 2 points in the score for the range of motion, but the scores for pain and function improved 6 points from 2 points.

The overall scores could be obtained 32.5 points (range, 21-35) from 13.5 (range, 8-23) in the group Ⅰ, and 30.1 points (range, 25-35) from 12.9 (range, 10-17). Eighty nine percents in the group Ⅰ and eighty two percents in the group Ⅱ had a good or excellent results.

One patient experienced paresthesia at the shoulder and upper arm after the interscalene block and this symptom had discontinued 4 months after arthroscopic surgery. This patient eventually obtained a good result and was satisfied with the operation.

Discussion

The primary goal of surgical intervention for the vast majority of the patients who had a refractory impingement syndrom and partial thickness rotator cuff tear is to decrease pain, including rest pain, night pain and pain with activities of daily living. Additional goals of surgery are to improve shoulder function and to limit the progression of rotator cuf tendinopathy.

Since the anterior acromioplasty had been recommended by Neer[7], the overall satisfactory results in most reviews were 70% to 90% with open acromioplasty[5,9,10,12,14]. Hawkins and Adams[5] reported on 108 open acromioplasty with intact rotator cuff and there was an overall success rate of 86 percent relating to pain relief. They described that patients who exhibited a decreased range of motion preoperatively and patients with neck pain preoperatively accounted for a higher percentage of failures. Neer[7] stressed the importance of a secure reattachment of the deltoid to the anterior acromion. He recommended repair to the remaining deltotrapezius fascia while others have utilized sutures passed through the bone of the anterior acromion. Rockwood and Lyons[10] modified this technique to include removing the entire portion of the acromion anterior to the AC joint as a guide to the extent of anterior acromion resection. They reported 89% good and excellent results after modified acromioplasty for patients who had had intact rotator cuffs. However, the complicatons of open acromioplasty include problems of the deltoid detachment or avulsion from the reattachment to the remaining acromion and resultant scarring in the subacromial space. In an attempt to avoid these problems associated with open acromioplasty, the technique of arthroscopic acromioplasty[2] was developed and the theoretical advantages this procedure were decreased patient morbidity, out-patient or one day surgery, avoidance of problems associated with deltoid detachment, and the ability for intra-articular inspection of the joint and undersurface of the rotator cuff. The surgical technique is demanding, is associated with a considerable learning curve, and has its own potential for problems. But, published report[3,4,13] have been encouraging and

many surgeons currently employ this method for the treatment of all patients with unresponsive stage II impingement. Ellman and Kay[3] reported on arthroscopic subacromial decompression for chronic impingement. At two to five year followup, 89% of the cases in their study achieved a satisfactory result. Gartsman et al.[4] described his results after arthroscopic acromioplasty and no significant difference was noted between patients with an intact cuff and those with a partial cuff tear. But the results were noted to be worse in those patients with full thickness cuff tears. Speer et al.[13] reported 88% good and excellent results after arthroscopic acromioplasty for patients with intact rotator cuffs. Lazarus et al.[6] reviewed their results comparing open and arthroscopic acromioplasties with stage II impingement and partial rotator cuff tears and reported there were no statistical difference between the groups in mean postoperative shoulder scores. But 87.5% of patients were satisfied in open surgery, whereas in arthroscopic surgery, 76.7% were satisfied. They noted calcification might be associated with a worse result. Sachs et al.[11] documented that there were no significant differences in results of open and arthroscopic acromioplasty at 1 year, with 21 of 22 (95%) open patients and 17 of 19 (90%) arthroscopic patients evaluating themselves as moderately or completely improved. Of these totals, 68% of arthroscopic and 59% of open patients were completely improved.

In our study, there was an ascendancy of good and excellent results in arthroscopic acromioplasty group. Concerning the pain relief and function improvement, the arthroscopic group achieved a slight better and more predictable result than the open group. In arthroscopic group, the scores for postoperative pain ranged 6 to 10 points, whereas ranged 2 to 10 points in open group. The final outcome for function was good or excellent in all of patients who underwent arthroscopic surgery, however it was so variable in open group. There was no signifecant difference in the postoperative active forward flexion at the last follow up as compared with each group. Two patients who had had biceps lesion had 22 points postoperatively both in arthroscopic and open surgery. The presence of biceps lesion might be the adverse effect on outcome.

In conclusion, both arthroscopic and open acromioplasty can lead to excellent results in the majority of patients who had a refractory impingement syndrome and partial thickness rotator cuff tear. Arthroscopic acromioplasty was associated with better and more predictable results. Preservation of the origin of the deltoid during an arthroscopic acromioplasty reduced the postoperative morbidity and made it possible to start rehabilitation sooner and achieve the better results.

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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

本会の事務局を、横浜市中区新山下3－2－3

横浜市立港湾病院内に置く

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　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、理事長が理事会及び評議員会の議を経て推薦するもの

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３年とし、再任は妨げない

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）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

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

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
河野　左宙	鞆田　幸徳	W. Pforringer
榊田喜三郎	鳥山　貞宣	George A Snook
鈴木　良平	廣畑　和志	

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　　廣畑　和志

評 議 員

赤松　功也	城所　靖郎	菅原　　誠	廣橋　賢次	山本　博司
阿曽沼　要	栗山　節郎	高尾　良英	福田　宏明	山本　龍二
阿部　正隆	黒坂　昌弘	高倉　義典	福林　　徹	横江　清司
有馬　　亨	黒澤　　尚	竹下　　満	藤巻　悦夫	吉松　俊一
井上　　一	古賀　良生	竹田　　毅	星川　吉光	龍　順之助
今井　立史	腰野　富久	田島　　寶	増島　　篤	若野　紘一
今給黎篤弘	小山　由喜	立花　陽明	松井　宣夫	渡辺　好博
入江　一憲	斉藤　明義	田中　寿一	松崎　昭夫	渡会　公治
上崎　典雄	左海　伸夫	土屋　正光	圓尾　宗司	
大久保　衛	阪本　桂造	戸松　泰介	宮津　　誠	
岡崎　壮之	酒匂　　崇	冨永　積生	宮永　　豊	
岡村　良久	史野　根生	丹羽　滋郎	武藤　芳照	
越智　隆弘	柴田　大法	乗松　敏晴	茂手木三男	
越智　光夫	霜　礼次郎	乗松　尋道	森　雄二郎	
加藤　哲也	白井　康正	林　浩一郎	安田　和則	
菊地　臣一	須川　　勲	平澤　泰介	矢部　　裕	

（敬称略）

賛助会員

(96年度)

旭化成工業株式会社
株式会社アムコ
石井医科工業株式会社
科研製薬株式会社
三共株式会社
三進興産株式会社
塩野義製薬株式会社
株式会社武内義肢製作所
日本シグマックス株式会社
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日本ルセル株式会社
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株式会社ヘリオ
株式会社松本医科器械
マルホ株式会社

学術集会について

第23回　日本整形外科スポーツ医学会

会　期：1997年５月15日(木)、16日(金)
会　場：高輪プリンスホテル
　　東京都港区高輪３－13－１
　　TEL.03-3447-1111

演題募集

主　題：１）スポーツ障害と画像診断
　　２）ＡＣＬ損傷と合併損傷の診断と治療
　　３）スポーツ障害の予防と早期復帰への工夫
パネルディスカッション：アキレス腱皮下断裂の治療

演題締切り

一次締切り：1996年11月15日(金)
　　官製葉書に演題名、発表者氏名、所属、住所を記入の上、事務局までお申し込み下さい。折り返し抄録用紙をお送りいたします。
二次締切り：1996年12月15日(日)
連絡先：〒143 東京都大田区大森西６－11－１
　　東邦大学整形外科学教室内
　　第23回日本整形外科スポーツ医学会事務局
　　TEL.03-3762-4151（内3575）
　　FAX.03-3763-7539（直通）
　　会長　茂手木　三男

第24回　日本整形外科スポーツ医学会

会　長：赤松　功也（山梨医科大学整形外科教授）

報告とお知らせ

日本整形外科スポーツ医学会 第6回理事会 議事録1

日　時：1996年8月28日(水)15：30～17：30
場　所：筑波第一ホテル　別館　夕映の間
出席者：東　　博彦、井形　高明、石井　清一、高澤　晴夫
田島　直也、中嶋　寛之、林　浩一郎、原田　征行
廣畑　和志、守屋　秀繁、茂手木　三男
(事務局)李　栄子、佐々木　由美
欠席者：生田　義和

《議題》

1．第22回日本整形外科スポーツ医学会　学術集会　会長　あいさつ

2．第22回日本整形外科スポーツ医学会　学術集会の報告
林　先生よりごあいさつと学術集会についてご報告があった。
本年度からスポーツ実践の単位が無くなったこと、本年は応募演題138題を全採用したこと等、報告があった。

3．次期会長　あいさつ
茂手木先生よりごあいさつと会期、テーマについてご報告があった。(資料配布)

4．第４回　日韓整形外科スポーツ医学国際会議　報告
原田先生よりご報告があった。(資料２)
日本側29演題、韓国側16演題、シンポジウム７題、ＧＯＴＳのフェローの発表演題３題があり、盛会に終了したことが報告された。

5．庶務会計報告
高澤先生よりご報告があった。(資料３－１～３－７)
95年度決算報告後、監事の廣畑先生より、会計事務が正確に行なわれていることが報告された。
96年度予算案で次年度繰越金を予備費としたほうがよいとのご意見があり、訂正することとした。
96年度予算案の収入の部の会費収入が少ないのではないかというご指摘があったが、例年、当該年度の会費を収める会員が1300人程度であるので見積もった金額であることが説明された。

6．事務局の所在地変更について
事務局の所在地は恒久的な方が望ましいし、会則の変更にも関わることからこれを検討する委員会を設けることが承認された。

7．役員改選について
役員（理事、監事）が任期満了のため改選について討議された。役員の改選方法に規約が無いため、来期（97・98・99年）も現在の役員が任期を延長することとし、内規を設置する会則委員会で検討することにした。

8．評議委員改選について
役員同様、評議員に関する内規を整備する委員会を設置することとした。
評議員アンケートの結果から、辞任希望者があることが報告されたが、あらためて正式な文書によって、辞任の意志を伺うこととした。
来期の評議員については、自薦、他薦で候補が挙げられたが、これも選出方法が無く、公募もしていないことから、内規を設置する会則委員会で検討することにした。

9．評議委員アンケート調査報告（アンケート結果配布）
大変貴重な意見が寄せられているので、今後の学会活動に多いに役立ていくことが確認された。

10. 新委員会の設置について
評議委員のアンケートから設置する委員会の候補が挙げられたが、以下の５つの委員会の設置が承認された。
以下の委員会の内容については、８月29日㈭に開かれた理事会で報告された内容に基づいて記載する。

①会則等検討委員会……役員、評議員の選出および改選に関する内規の整備
会則改正の検討（事務局の所在地の変更等）
その他、会則等に関する事項
※この委員会は検討事項が終了すれば、解散できる。

②庶務委員会　……事務局の運営
予算、決算等　会計の執行、管理
財務（募金活動）
事務局員の退職金の検討
その他庶務に関する事項

③学術検討委員会　……学術集会の充実
各種テーマを設けての研究活動
医学生に対するスポーツ医学の研修教育
財）日本スポーツ治療医学研究会の研究助成の審査
その他学術に関する事項

④国際委員会　……アメリカ、ヨーロッパ、アジアとのスポーツ医学の交流
JOSSM－KOSSM－GOTS間のFELLOWSHIP
日韓整形外科スポーツ医学国際会議

⑤広報委員会　……スポーツ医学の一般への教育、広報
マスコミ対応
パンフレットの作成
Ｐ．Ｔ．トレーナーの研修
スポーツドクターの問題

⑥編集委員会(既存)……学会雑誌の編集、企画

11. 次期会長以降の会長について
来年度、再来年度の会長を決定した。
2000年の会長に日本医科大学の白井先生が立候補されているので、承認することとした。
12. 平成７年度　財）日本スポーツ治療医学研究会　研究助成　報告
平成７年度の研究助成者が報告された。
本学会としての推薦となるで、応募された研究について審査する機関が必要であるというご意見があった。
今後、学術検討委員会が発足すれば、そこで担当する事柄となるので、審査方法についてもそこで検討されることとなった。
13. 96年度　JOSSM／KOSSM／GOTS TRAVELLING FELLOW 報告
96年度　JOSSM／KOSSM／GOTS TRAVELLING FELLOW の報告があった。
（資料４）
14. 97年度　JOSSM／KOSSM／GOTS TRAVELLING FELLOW 募集について
国際委員会を発足し、選出方法などについて検討を要することが承認された。
（参考資料）
15. その他報告
事務局に届いている海外のスポーツ医学会の案内の資料の添付があった。

委員会の設置と担当について討議する時間が不足していたため、再度理事会が開かれた。

日本整形外科スポーツ医学会 第6回理事会 議事録 2

日　時：1996年８月29日㈭16：30～18：00
場　所：筑波第一ホテル　別館　夕映の間
出席者：東　　博彦、井形　高明、石井　清一、高澤　晴夫
　　田島　直也、中嶋　寛之、林　浩一郎、原田　征行
　　守屋　秀繁
　　(事務局)李　栄子、佐々木　由美
欠席者：生田　義和、廣畑　和志、茂手木　三男

議題　10. 新委員会の設置について

委員会の設置については、早急に処理すべき問題のある委員会の発足を先にした方がよいのではないかというご意見や委員会の内容を吟味すべきであるというご意見もあったが、５つの委員会を同時に発足することとなった。

５つの新委員会はそれぞれの委員会に担当理事を決めて、担当理事が委員を６名程度推薦することとした。

担当理事は委員会の委員長を兼ねず、別に委員長を選出する日整会方式で組織づくりをしてはどうかという理事長の提案があった。

担当理事は委員会の委員の候補を事務局に送付し、理事長と常任理事で人選について話し合うこととした。

担当理事は下記のとおりである。理事長（高澤）は全体を統括する。

①会則等検討委員会……原田
②庶務委員会……井形、石井
③学術検討委員会……守屋
④国際委員会……田島、生田
⑤広報委員会……中嶋　　（敬称略）

議題　“BEST PAPER OF THE YEAR”について
昨年度は学会の発表演題から選んだが、本年度からはどのように選出するか討議された。

学会雑誌に投稿される発表演題から選ぶこととなり、全演者にアナウンスすることとした。
投稿締切後、審査することとした。
受賞者に渡す賞状を作成することとした。

参考　“BEST PAPER OF THE YEAR”
本年度における最優秀研究発表１題に対し、（株）松本医科器械より褒賞として、１名に1997年度のアメリカ整形外科スポーツ医学会（AOSSM）の出席のための旅費、滞在費が支給されるもの。選考は本年度の学術集会の会長、前会長、次期会長で行なう。

議題　編集委員の査読料について

１編について査読料を支払うのでなく、委員を終了するとき記念品を贈呈してはどうかという案があり、承認された。

1996年９月12日　議事確認　第22回学術集会会長 林　浩一郎

日本整形外科スポーツ医学会　庶務報告

（1996年７月31日現在）

現会員数	1,717名
内、名誉会員	10名
95年度会員（95.3.31時点）	1，609名
96年４月以降新入会員	114名
96年４月以降退会者	６名
内、物故会員	１名

大戸　輝也　先生（都共済清瀬病院）
1996年４月14日　ご逝去

日本整形外科スポーツ医学会　１９９５年度　決算報告書

（１９９５年４月１日から１９９６年３月３１日まで）

【収入の部】

科　　目	１９９５年度予算額	１９９５年度決算額
１．年　会　費	１５，６００，０００	１７，４４８，０００
賛　助　会　費	１，０００，０００	１，４５０，０００
２．雑誌掲載料	６００，０００	６４４，５００
３．広告掲載料	１，５００，０００	１，１４０，０００
４．雑　収　入	４０，０００	６５，０２２
５．前年度繰越金	９，１８９，４１７	９，１８９，４１７
合　　計	２７，９２９，４１７	２９，９３６，９３９

【支出の部】

科　　目	１９９５年度予算額	１９９５年度決算額
１．学会雑誌発行費		
印刷費（３冊）	７，０００，０００	６，８１２，７２０
発送費	１，５００，０００	１，３１７，９７７
発送用封筒等印刷費	２５０，０００	９２，７００
２．学術集会開催費	１，０００，０００	１，０００，０００
３．委　員　会　費	１，５００，０００	５６９，９４０
４．理　事　会　費	５００，０００	１０１，８４６
５．国際学術交流関係費	２，０００，０００	１，０９８，５００
６．学会(日韓)開催補助費	１，０００，０００	１，０００，０００
７．運　営　費		
人　件　費	２，５００，０００	２，５００，０００
交　通　費	５００，０００	２６６，５１０
印刷製本費	３００，０００	２４９，８９５
通　信　費	７００，０００	８９３，０８３
消耗品費	２００，０００	２３１，７２５
雑　　費	２００，０００	８８，４４０
小　　計	１９，１５０，０００	１６，２２３，３３６
次年度繰越金	８，７７９，４１７	１３，７１３，６０３
合　　計	２７，９２９，４１７	２９，９３６，９３９

日本整形外科スポーツ医学会　1996年度　予算案

（1996年4月1日から1997年3月31日まで）

【収入の部】

科　目	1995年度予算額	1996年度予算額
1．年　会　費	15，600，000	15，600，000
賛　助　会　費	1，000，000	1，000，000
2．雑誌掲載料	600，000	600，000
3．広告掲載料	1，500，000	1，000，000
4．雑　収　入	40，000	50，000
5．前年度繰越金	9，189，417	13，713，603
合　計	27，929，417	31，963，603

【支出の部】

科　目	1995年度予算額	1996年度予算額
1．学会雑誌発行費		
印刷費（3冊）	7，000，000	7，000，000
発送費	1，500，000	1，000，000
発送用封筒等印刷費	250，000	150，000
2．学術集会開催費	1，000，000	1，000，000
3．委　員　会　費	1，500，000	1，500，000
4．理　事　会　費	500，000	500，000
5．国際学術交流関係費	2，000，000	1，500，000
6．学会(日韓)開催補助費	1，000，000	
7．運　営　費		
人　件　費	2，500，000	2，500，000
交　通　費	500，000	400，000
印刷製本費	300，000	300，000
通　信　費	700，000	900，000
消耗品費	200，000	250，000
雑　費	200，000	100，000
小　計	19，150，000	17，100，000
予　備　費	8，779，417	14，863，603
合　計	27，929，417	31，963，603

日本整形外科スポーツ医学会 年会費について

金　　額 ： 1996年度　　12,000円

納入方法 ： 1）銀行振込—なるべく学会雑誌に綴込んである振込依頼書をご利用下さい。払込金受取書が領収書となりますので，各自保管して下さい。

振込依頼書のない場合は，下記口座宛お振込願います。その際，必ず個人名でお振込下さい。(大学名，病院名で振込まれますと入金が確認できない場合があります。)

さくら銀行　横浜支店
普通預金　6318135
日本整形外科スポーツ医学会

2）自動振替—所定の用紙に必要事項をご記入，捺印の上，事務局宛送付願います。（但し，1996年度年会費については既に振替処理を終了しておりますので，これからお申し込みの方は1997年度以降の適用となります。)

※振込依頼書，及び自動振替依頼書は，学会雑誌（毎年No. 1 巻）に綴込んでありますが，ご必要の際は事務局までご請求下さい。

※学会雑誌（No. 1 巻)には，既に年会費を振込まれた方，自動振替の手続きをされた方にも各依頼書は綴込んでありますので，二重支払いにならないようご注意願います。(支払い済か，否かご不明の方は，事務局迄お問い合わせ願います。)

※毎年12月末日迄に当該年度の年会費を納めた会員に，翌年発行の学会雑誌を送付致します。未納の方は，期日迄に必ずお振込み下さい。

※２年以上年会費を滞納されると，自動退会となりますので，ご注意願います。

広報だより

—— 各種委員会報告 ——

学術検討委員会 担当理事　守 屋 秀 繁

第22回日本整形外科スポーツ医学会総会において、医科学生の体育大会での重篤なスポーツ外傷を予防する目的で「全国医学部スポーツドクター協議会（仮称）」の設立が提案され、可決されました。

それを受けて学術検討委員会では全国の大学医学部長又は医科大学長および整形外科主任教授に委員推薦の依頼を行い、以下の委員の推薦を頂きました。

委員会の今後の運営等については後日連絡させて頂きます。

全国医学部スポーツドクター協議会（仮称）委員　推薦者　一覧

	大　学　名	推　薦　者	被　推　薦　者
1	北海道大学	金田　清志	安田　和則
2	旭川医科大学	― ― ―	
3	札幌医科大学	石井　清一	成田　寛志
4	弘前大学	原田　征行	岡村　良久
5	岩手医科大学	阿部　正隆	一戸　貞文　（講師）
6	秋田大学	佐藤　光三	井樋　栄二　（講師）
7	東北大学	國分　正一	梅原寿太郎・杉田　健彦
8	山形大学	荻野　利彦	井田　英雄　（講師）
9	群馬大学	白倉賢二（助教授）	白倉　賢二　（助教授）
10	福島県立医科大学	菊地　臣一	吉田　仁郎　（講師）
11	筑波大学	林　浩一郎	宮川　俊平　（講師）
12	独協医科大学	早乙女紘一	酒井　宏哉　（講師）
13	自治医科大学	星野　雄一	刈谷　裕成　（講師）
14	埼玉医科大学	東　博彦	立花　陽明　（講師）
15	防衛医科大学校	冨士川恭輔	根本　孝一　（講師）
16	千葉大学	守屋　秀繁	和田　佑一
17	東京大学	黒川　高秀	福井　尚志
18	順天堂大学	山内　裕雄	桜庭　景植　（講師）
19	東京慈恵会医科大	藤井　克之	田中　孝昭
20	東京医科歯科大学	山本　晴康	宗田　大（講師），・荻内　隆司
21	東邦大学	茂手木三男	土谷　一晃　（講師）
22	東京女子医科大学	伊藤　達雄	池田　和男・入江　一憲（講師）
23	日本大学	佐藤　勤也	斎藤　明義　（講師）
24	慶応義塾大学	矢部　裕	竹田　毅　（講師/ｽﾎﾟｰﾂｸﾘﾆｯｸ）

	大学名	推薦者	被推薦者
25	東京医科大学	三浦　幸雄	今給黎篤弘（教授）・香取庸一
26	帝京大学	立石　昭夫	小島　達也　（講師）
27	昭和大学	藤巻　悦夫	阪本　桂造（助教授）
28	杏林大学	石井　良章	小谷　明弘
29	日本医科大学	白井　康正	成田　哲也（講師）・沢泉　卓哉
30	東海大学	福田　宏明	中村　豊　（東海大学スポーツ医科学研究所）
31	聖マリアンナ医科大学	青木　治人	別府　諸兄　（助教授）
32	北里大学	糸満　盛憲	北爪　伸仁　（北里大学東病院）
33	横浜市立大学	腰野　富久	斎藤 知行（講師）・酒井 直隆（講師）
34	山梨医科大学	赤松　功也	浜田　良機　（助教授）
35	新潟大学	高橋　栄明	大森　豪
36	信州大学	高岡　邦夫	中土　幸男　（助教授）
37	富山医科薬科大学	辻　陽雄	山田均（高岡市民病院）・北川秀機（講師）
38	金沢大学	富田　勝郎	北岡　克彦　（助手）
39	金沢医科大学	東田　紀彦	藤井　正則　（講師）
40	福井医科大学	井村　慎一	和田　真　　（講師）
41	浜松医科大学	井上　哲郎	傳田　正史
42	名古屋大学	岩田　久	清沢　卓也
43	名古屋市立大学	松井　宣夫	小林正明（助手）・杉本勝正
44	藤田保健衛生大学	吉澤　英造	中川　研二（助教授）
45	愛知医科大学	丹羽　滋郎	本庄　宏司（講師）・山路　倫生
46	岐阜大学	清水　克時	益田　和明　・　石井　光一
47	三重大学	内田　淳正	浦和　真佐夫
48	滋賀医科大学	福田　眞輔	吉川　玄逸
49	京都大学	中村　孝志	松末吉隆（講師）・中川泰彰（助手）
50	大阪市立大学	山野　慶樹	日高　典昭

	大学名	推薦者	被推薦者
51	京都府立医科大学	平澤　泰介	麻生　伸一
52	大阪医科大学	阿部　宗昭	木下　光雄　（助教授）
53	大阪大学	越智　隆弘	中田　研
54	近畿大学	田中　清介	浜西　千秋（助教授）・菊地　啓（講師）
55	関西医科大学	小川　亮恵	森本　忠信
56	神戸大学	水野　耕作	黒坂　昌弘　（助教授）
57	兵庫医科大学	圓尾　宗司	田中　寿一（講師）・松本　学（講師）
58	和歌山県立医科大	玉置　哲也	玉置　哲也
59	奈良県立医科大学	玉井　進	高倉　義典　（助教授）
60	川崎医科大学	渡辺　良	日野　洋介　（講師）
61	岡山大学	井上　一	千田　益生　（助手）
62	鳥取大学	山本　吉蔵	縄田　耕二
63	島根医科大学	越智　光夫	朱　尚孝（講師）・内尾　祐司（講師）
64	広島大学	生田　義和	藤本吉範（講師）・望月由・数面義雄
65	山口大学	河合　伸也	河合　伸也　（教授）
66	愛媛大学	柴田　大法	沖　貞明　（講師）
67	徳島大学	井形　高明	柏口　新二　（講師）
68	香川医科大学	乗松　尋道	辻　伸太郎（助手）・ 石川　澄（医療情報部 内科系 助教授）
69	高知医科大学	山本　博司	川上　照彦　（リハビリテーション 助教授）
70	産業医科大学	中村　利孝	沖本　信和・内田　宗志
71	九州大学	岩本　幸英	高杉　紳一郎（リハビリテーション科 助手）
72	福岡大学	緒方　公介	原　道也
73	久留米大学	井上　明生	阿部　隆伸
74	長崎大学	伊藤 信之（助教授）	衛藤　正雄
75	大分医科大学	眞角　昭吾	藤島　英典（助手）
76	宮崎医科大学	田島　直也	帖佐　悦男・園田　典生

	大　学　名	推　薦　者	被　推　薦　者
77	熊本大学	高木　克公	白石　稔
78	佐賀医科大学	渡邊　英夫	忽那　龍雄（兼任教授　[illegible]）
79	鹿児島大学	酒匂　崇	武富　栄二　（講師）
80	琉球大学	茨木　邦夫	上里　智美（[illegible]）

1996年11月15日現在

学会開催のお知らせ(国内)

第14回 中部日本手の外科研究会 開催のお知らせ

第14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願いいたします。

記

会　期：平成９年１月25日（土）

会　場：東海テレビ テレピアホール
〒461 名古屋市東区東桜１－14－27
TEL. 052-954-1165

主　題：１）手の装具の工夫と装具による障害治療
（装具の展示も行います）
２）遠位橈尺関節障害の治療
（尺骨突き上げ症候群、脱臼、亜脱臼、ＯＡなど）
３）手関節鏡による手関節障害の診断、治療

連絡先：〒461 名古屋市東区大幸南１－１－20
名古屋大学医学部附属病院分院整形外科
第14回中部日本手の外科研究会事務局 宛
TEL. 052-723-1111／FAX.052-722-3191

※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）に直接ご連絡下さい。

第14回 中部日本手の外科研究会
会長 中 村 蓼 吾
（名古屋大学医学部附属病院分院整形外科）

第３回 日米加欧整形外科基礎学会合同会議 開催のお知らせ

この度、日米加欧整形外科基礎学会合同会議は第３回の学術集会を下記の通り日本で開催することになりますたので、ここにご案内申し上げます。

皆様のご参加をお待ちいたしております。

なお合同会議のアナウンスメントの直接送付を希望される方は、お手数でも下記日本事務局まで、葉書またはファックスでお申し込み下さい。

日本側組織委員会　廣谷速人・平澤泰介・岩田久・
藤井克之・高木克公

記

会　期：平成10(1998)年９月28日(月)～30日(水)

会　場：浜松市　アクトシティー浜松

シンポジウム：

1.Bone：From the Cradle to the Grave

2.Spine：Fundamentals of Back Pain

3.Joint：Challenges in Impaired Articulation

日本事務局：〒463 名古屋市守山区四軒家１－1521
重冨医療グループ統合本部　廣谷速人
☎052－776－2501　FAX：052－776－2508

第３回バイオメニクス世界会議

(The Third World Congress of Biomechanics)

1990年にカリフォルニア大学サンディエゴ校で開催された第１回会議、1994年にアムステルダム自由大学で開かれた第２回会議に引き続いて、頭記第３回会議が下記の概要で我国において開催されます。会員各位の積極的なご参加を歓迎致します。

主催：日本学術会議、日本バイオメカニクス研究連絡協議会
後援：日本整形外科スポーツ医学会、北海道、札幌市他20学会、学術団体
期日：1998年８月２－８日
会場：北海道大学（札幌市）
内容：１.Cardiovascular Biomechanics
２.Respiratory Biomechanics
３.Bone and Hard Tissue Biomechanics
４.Skeletal and Musclular Biomechanics
５.Joint Biomechanics
６.Spine Biomechanics
７.Head Biomechanics
８.Oromaxillofacial Biomechanics
９.Sensory Organs Mechanics
10.Cellular and Molecular Biomechanics
11.Biorheology
12.Biofluid Dynamics
13.Biothermodynamics and bioheat conduction
14.Connective Tissue Biomechanics
15.Biomaterials and Medical Devices
16.Artificial Organs and Implants
17.Biomechanics and Rehabilitation
18.Physical Activities and Sports Biomechanics
19.Measurement and Analysis for Biomechanics
20.Modeling and Simulation for Biomechanics
21.Animal Biomechanics
22.Others
発表申込締切：1997年11月１日
事務局及び会議案内請求先：
〒560 豊中市待兼山町１－３　大阪大学基礎工学部機械工学科内
第３回バイオメカニクス世界会議事務局
TEL：06-850-6170（林紘三郎）、-6181（田中正夫）
FAX：06-850-6171
E-MAIL：hayashi@me.es.osaka-u.ac.jp
tanaka@me.es.osaka-u.ac.jp
(1st Circularは1996年12月より配布する予定です)

学会開催のお知らせ(海外)

下記の会議は日本整形外科スポーツ医学会事務局宛てに届いた案内です。
会議名・期間・開催場所・代表者・連絡先の順で掲載してあります。

◆Double-Header Seminer
Feburuary 1-5 1997
Dodgertown, Vero Beach, Florida, U.S.A
Frank W. Jobe, M.D.
Athletic Conferences, INC.
139 Van Ness Avenue 158 Gardena, CA 90249

◆American Academy of Orthopaedic Surgeons
Feburuary 13-17 1997 Sanfrancisco, U.S.A.
AAOS Annual Meeting Register
6300 North River Road Rosemont, IL
60018-4262 U.S.A.
Tel : 1-800-346-2267　Fax : 1-847-823-8031

◆AOSSM 23rd Annual Meeting
June 22-25 San Valley Idafo, U.S.A
6300 North River Road, Suite 200
Rosement, Illinois 60018 U.S.A
Tel : 1-708-292-4900

◆Combined Meering of GOTS／AOSSM／EFOST
(GOTS-Gesellshaft fur Orthopädisch Traumatologische Sportmedizin
AOSSM-American Orthopaedic Society for Sports Medicine
EFOST-European Feederation of Orthopaedic Sports Traumatology)
June 26-29 1997 München, Germany
Meinolf Goertzen, M.D.
Dept. of Orthopaedic Surgery
Heinrich-Heine-Unversity
Moorenstr, 5, D-40225 Dusseldorf Germany
Tel : 49-211-8117058　Fax : 49-211-8117073
http://www.dimos.de/orthonet/gots/

◆12th Western Pacific Orthopaedic Association Congress
November 2-6 1998 Fukuoka, Japan
Yosiharu Takemitsu, M.D.
PMSI Japan, Ltd Royal Bldg. 12-8 Nibancho
Chiyoda-ku Tokyo 102 Japan
Tel : 13-5275-6991　Fax : 03-5275-6994

本誌に掲載を希望する学会開催案内がありましたら、事務局あてにお送り下さい。

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Yokohama 231 JAPAN

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