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Attrition Lesions of Articular Cartilage in Japanese Knee

Joint due to Formal Sitting and Squatting Postures*

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Abstract As well known, Japanese habitually adopt formal sitting and squat-ting postures, the extreme flexion of the knees allowing of this. The influ-ence exercised by pressure and posture are, therefore, found at the knee joints in Japanese. The attrition lesions of articular cartilage due to the postures in question are present on the supero-posterior surfaces of the lateral and medial femoral condyles as well as in the posterior one-third of the meniscus-covered segment on the lateral tibial condyle. The sites involved are func-tionally explained in relation to the mechanism of the joint. The attrition lesions are more frequent in females than in males. The decreased frequen-cies of the lesions in males are attributed to their postural habit of tending to adopt sartorial position. The attrition lesions include roughening, ulcera-
tion and destruction of articular cartilage. The onset is over thirty years of
age, and the lesions are in order of increasing frequency with advancing
age. It is suggested that the attrition lesions of articular cartilage sometimes
bring the knee joint to osteo-arthritis.

INTRODUCTION

Since THOMSON's paper (1889), it has
often been suggested that the modifica-
tions of bone due to squatting posture are
found in different groups of human popu-lations. The modifications are generally found in the lower limb skeletons of which the hip, knee, ankle and subtalar joints are composed. At the knee joint, the main types of modifications described by previous workers are three; (a) forma-tion of the facet of CHARLES (1893) on

* This paper is dedicated to Emeritus Profes-sor Hisashi SuzuKI of the University of Tokyo in commemoration of his seventeeth birthday.

the superior surface of the medial femoral condyle, (b) increased convexity of the su-

perior surface of the lateral tibial condyle, and (c) enlarged supero-lateral facet on the articular surface of the patella. The bony modifications as seen at the knee joint are the changes in structure that function may bring about. It can be as-sumed here that the influence exercised

by pressure and posture will be seen not only in the bony structure, but also in the articular cartilage.
As well known, Japanese habitually adopt formal sitting and squatting pos-tures in their daily life. The postures in question are adopted by both males and females, the habit acting from the earliest

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childhood. The so-called sartorial posi-
tion is alike often used by Japanese males, sitting cross-legged on the floor. Very
few Japanese females, however, adopt
this rather comfortable posture. In formal
sitting posture, the front of the leg and the dorsum of the foot rest on the floor, the ankle being extremely extended. In squatting posture, however, only the sole of the foot is attached on the floor; in fact the ankle is strongly flexed. In both formal sitting and squatting postures, man sits on his heels, the extreme flexion of the knees allowing of this. The changes in the articular cartilage caused by ab-normal stress and strain would, therefore, be found at the forcibly flexed knee joint. In this paper, the attrition lesions of articular cartilage at the tibio-femoral articulation in Japanese knee joint due to formal sitting and squatting postures are described and discussed.

MATERIALS AND METHOD

The observations here presented were made on 257 Japanese cadavers aged be-tween 17 and 94 years in the laboratories of the Department of Anatomy of Shinshu University School of Medicine, Matsumo-to, and of the Department of Anatomy of Niigata University School of Medicine, Niigata. In all, 178 femora and 275 tibiae from the legs of 142 males and 177 femora and 219 tibiae from those of 115 females were studied.
After the removal of the muscles, artic-ular capsule, ligaments and menisci at the knee joint which were dissected by the students according to a uniform method,

the observations were made upon the car-tilage-covered articular surfaces of the femoral and tibial condyles by the naked eye.
OBSERVATIONS

Those attrition lesions of articular car-

tilage at the tibio-femoral articulation in Japanese knee joint which are to be at-tributed to the formal sitting and squat-ting postures can be classified into three categories ; (a)localized roughening (fibril-lation), (b) ulceration (superficial loss), and (c) destruction(complete loss). When the cartilage is completely destroyed, the articular surface more or less shows pol-ishing or eburnation through the move-ment of bone on bone or meniscus. The attrition lesions, if present, are found in the supero-posterior parts of the articular surfaces on the femoral condyles as well as in the posterior one-third of the me-niscus-covered segment of the articular surface on the lateral tibial condyle. In addition, the attrition lesions in the bare area of the articular surface on the medial

tibial condyle are recorded. The photo-graphic pictures of the attrition lesions in question are given in Figs. 1 and 2. The various types of the attrition lesions on the femoral and tibial condyles are also photographically depicted in Figs. 3 and 4, respectively.
The percentages of occurrence of the attrition lesions on the femoral and tibial

condyles are shown in Table 1. From this table, it will be seen that no signifi-cant differences in the frequencies of the lesions are found between the right and

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Pig.1. The attrition lesions of articular cartilage at a couple of the knee joints in a Japanese male aged of 71 years.

left sides in both males and females. It is interesting to note that the lesions are, in general, more abundant in females than in males. The same table shows that there are no significant differences in the percentages of occurrence of the lesions between the lateral and medial femoral condyles in both sexes. In the tibia, how-ever, the lesions are more frequent on the lateral condyle than on the medial. It should be noticed here that the attrition lesions of articular cartilage are the most

frequent on the lateral tibial condyle in both sexes, and that the lesions are found in the majority of the female tibiae. The segment of the medial tibia! condyle which is covered by the meniscus never show the attrition lesions of articular

cartilage when the meniscus is normal and is everywhere intact. In the cases in which the attrition lesions in the bare area of the articular surface on the medial

tibial condyle extend to this meniscus covered segment, however, the lesions are

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Fig.2, The attrition lesions of articular cartilage at a couple of the knee joints in a Japanese male aged of 71 years.

exceptionally observable under cover of
the meniscus.
The percentages of occurrence of the
attrition lesions on the lateral and medial condyles of the femur and tibia in the different ages are given in Table 2. It can be seen in this table that the attrition lesions on the lateral tibial condyle begin to appear in the females aged thirties, whereas the lesions on the other condyles occur first in both males and females over fourty years of age. It can be also

seen that the attrition lesions on the fem-oral and tibial condyles in both sexes have a tendency to increase in frequency with advancing age.
The percentage divisions of three types of the attrition lesions of articular car-tilage on the femoral and tibial condyles are tabulated in Table 3. It is readily seen in this table that the ulceration of cartilage is of the commonest type in both males and females. The same table shows clearly that the attrition lesions

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Fig.4. The various types of the attrition lesions of articular cartilage on the right tibial condyles are shown. The arrows indicate the lesions, which are progressing
from the top of the left column to the bottom of the right.

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Table 1, The percentages of occurrence of the attrition lesions of articular cartilage on the femoral and tibial condyles.

Table 2, The percentages of occurrence of the attrition lesions of articular cartilage on the femoral and tibial condyles in the different ages.

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Table 3, The percentage division of three types of the attrition leasions of articular cartilage on the femoral and tibial condyles.

of ulcerated and destroyed types are more frequent in females than in males.
The percentage division of three types
of the attrition lesions of articular car-tilage on the femoral and tibial condyles in the various decades of life are shown in Table 4. It will be seen from this table that both roughening and ulceration of cartilage on the lateral tibial condyle starts from the age of thirties, while the onset of the ulceration of cartialge on the medial condyles of both femur and tibia is over fourty years of age. From the same table, it can be seen that the fre-quencies of the attrition lesions of ulcer-

ated and destroyed types tend to increase in both sexes with advancing age.
The data necessary for testing the cor-relation of the attrition lesions of articular cartilage between the lateral and medial condyles in the same bone are given in Table 5. The frequencies in every row of this table can be made into a contin-

gency or fourfold table in order to test for independence using the .05 signifi-cance level of chi square. From the val-ues of chi square statistic shown in Table 5, it is readily seen that the attrition lesions on the lateral and medial condyles in the same bone are not associated in

Attrition Lesions of Articular Cartilage 171 Table 4. The percentage division of three types of the attrition lesions of articular cartilage on the femoral and tibial condyles in the different ages.

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Table 5. The correlatieon of the attrition lesions of articular cartilag between the lateral and medial condyles in the same bone examined
by the chi square test.

Table 6. The correlation of the attrition lesions of articular cartilage between the femora and tibial condyles at the same knee joint exam-ined by the chi square test.

males except the left tibia, but closely related in females.
The correlation of the attrition lesions

of articular cartilage between the femoral and tibial condyles in the same knee joint examined similarly by means of the chi square test are exhibited in Table 6. This table shows clearly that the attrition lesions on the femur are strongly related to those on the tibia at the same knee

joint in both sexes, but for those on the

left lateral condyle in males.
The correlation of the attrition lesions

of articular cartilage between the right and left knee joints in the same individual examined by the chi square test are shown in Table 7. It will be seen from this table that the attrition lesions at the knee

joint tend to occur on both sides in the same individual.

In some of the knee joints observed, there develops the bony " lipping " which

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Table 7. The correlation of the attrition lesions of articular cartilage between the right and left knee joints in the same individual examined by the chi square test.

Table 8. The correlation between the attrition lesions of articular cartilage and the bony lipping on the same condyle examined by
the chi square test.

is known as a pathological osteophytosis associated with osteo-arthritis (synony-mous with degenerative or hypertrophic arthritis here). The chi-square tests of the correlation between the attrition le-

sions of articular cartilage and the bony lipping on the same condyle are shown in Table 8. As will be seen from this table, the attrition lesions are not associ-ated with the bony lipping on the tibial condyles in males and on the lateral tibial

condyle in females, but related to those on the femoral condyles in both sexes and on the medial tibial condyle in fe-males.

DISCUSSION

In formal sitting and squatting postures, the knee joint is forcibly flexed. When the joint is extremely flexed, the supero-posterior parts of the articular surfaces of the markedly curved and backwardly

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Table 9. The percentages of occurrence of the attrition lesions of articular cartilage
in Japanese knee joint with comparative data from American whites.

,# ,after KEEFER et al. (1934).

projecting femoral condyles abut on the
articular surfaces of the relatively flat
tibial condyles. Accordingly, it would be
easily accepted that the attrition lesions
on the supero-posterior surfaces of the femoral condyles are attributed to the extreme flexion of the knee joint due to formal sitting and squatting postures. In fact, the femoral condyles move and rest on the menisco-tibial surfaces, because the menisci are present in the interior of the knee joint. As the standard textbook of anatomy such as "Primary Anatomy" of GATES and BASMAJIAN (1955) has de-scribed, the medial meniscus is fixed to the tibia so that it can move but little; it serves merely to deepen the socket for the medial femoral condyle. It must, therefore, be kept in mind that the pos-terior half of the medial tibial condyle makes contact not only with the inferior surface of the medial femoral condyle in extreme extension, but also with the supero-posterior surface of this condyle in extreme flexion. The lateral meniscus

is attached to the tibia, in contrast, by relatively long fibers that do not interfere with its movement. The meniscus can

glide back and forth. When the thigh is flexed at the knee and the leg remains fixed (as when assuming the sitting posi-tion), the thigh rotates laterally during the first part of flexion, and the femur rolls backwards on the tibia. As flexion approaches its limit, the lateral femoral condyle slips backwards as a unit with the meniscus on the superior surface of
the lateral tibial condyle. This is the
reason why the attrition lesions on the lateral tibial condyle are usually found in the posterior one-third of the meniscus-covered segment. It can be also explained here that the above-mentioned increase

in convexity of the upper surface of the lateral tibial condyle in squatters is brought about by the backward movement of the lateral meniscus in flexion.
To examine the influence of formal sit-

ting and squatting postures on the artic-ular surfaces of the knee joint, the fre-quencies of the attrition lesions at the same sites as observed here in American whites (KEEFER et al., 1934) are compara-
tively shown in Table 9. From this
table, it becomes evident that the attri-tion lesions only on the medial tibial

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condyle are more frequent in American whites (who sit upon a chair and can not adopt, save at great inconvenience, formal sitting and squatting postures) than in Japanese, whereas those on the other con-dyles are of more frequent occurrence in the latter population. It is for this reason that the attrition lesions in the bare area

of the medial tibial condyle are not always caused by formal sitting and squatting postures.
As shown in Table 7, the attrition le-sions of articular cartilage are occasional-ly found at both right and left knee joints in the same individual. This is based on

the fact that the positions of the legs in formal sitting and squatting postures are almost symmetrical on the right and left sides.
Table 1 indicates that the attrition le-

sions of articular cartilage on the femoral and tibial condyles are more frequent in females than in males. Table 5 also ex-hibits that the attrition lesions on the

femoral and tibial condyles in the same bone are usually related in females, while those are mostly independent in males. These facts can be explained by their postural habit in Japanese males who often and informally adopt sartorial posi-tion to reduce the load of trunk weight on their legs, even though sex is an im-portant factor.
It is quite certain that age is also an important factor. Table 2 shows that the attrition lesions are not seen until after

30 years of age. The attrition lesions progress from roughening to ulceration, and further to destruction with advancing

age. The attrition lesions of destroyed type are generally accompanied with eburnation. Table 8 indicates that the

attrition lesions of articular cartilage is
sometimes combined with the bony lip-ping. It has to be realized that the at-trition lesions are associated with ageing of the tissues of the knee joint, and that they finally produce those changes which have been previously described as char-acteristic of osteo-arthritis. In the cases in which the attrition lesions are com-

bined with eburnation and upping, there is seemingly no line between the simple
attrition lesions of cartilage and the
changes associated with osteo-arthritis.
In consideration of the distribution of

affected sites, however, it may safely be
said that the cause of those attrition le-

sions which are simlar to the changes as-sociated with osteo-arthritis is directly related to the abnormal stress and strain

due to formal sitting and squatting pos-

tures.

SUMMARY

1, To examine the influence of formal sitting and squatting postures on the
articular cartilage at the tibio-femoral
articulation, 355 femora and 275 tibiae from the legs of 257 Japanese cadavers were observed.
2. The attrition lesions of articular

cartilage due to the postures in question were occasionally found on the supero-posterior surfaces of the lateral and me-dial femoral condyles as well as in the posterior one-third of the meniscus-cov-ered segment on the lateral tibial condyle.

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The sites involved were functionally ex-

plained in relation to the mechanism of
the knee joint.
3. The attrition lesions were more fre-

quent in females than in males. The decreased frequencies of the lesions in males were attributed to their postural habit of tending to adopt sartorial posi-tion.

4. The attrition lesions included rough-ening, ulceration and destruction of ar-ticular cartilage. The onset was over thirty years of age, and the lesions were in order of increasing frequency with advancing age.
5. It was suggested that the attrition lesions of articular cartilage sometimes brought the knee joint to osteo-arthritis.

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正座および蹲踞 の影響によると思われる日本人膝関節軟骨の磨耗について

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日本人遺体257体 の大腿骨355個 ・脛骨275個 を材料とし,正 座および蹲踞の影響による と思われる膝関節の脛骨大腿骨間連結における関節軟骨の磨耗ない し損傷につき観察 した。 問題の磨耗は,大 腿骨両顆の後上部および脛骨外側顆後端の外側半月に覆われる部分に限局的に頻発する。磨耗は30歳台に脛骨外側顆 に始まり, また加齢とともに関節軟骨の線維化 ・潰瘍形成 ・完全磨滅の順に漸次進行する。女性は男性より磨耗の発現が早 く,ま た頻度も高いが,こ れは男性が胡座(あ ぐら)を 多用することと関連するかもしれない。磨耗が高度になると変形性関節症に類似の変化がもたらされるが,好 発部位などをみれば,正 座および蹲踞が原因と分かる例が多い。