

Original Paper

Relationship between Degeneration of the Articular Cartilage of the Patellofemoral Joints and Anatomical Structure

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Abstract

The purpose of this study was to examine and measure the articular cartilage of the patellofemoral joint. We examined 84 patellofemoral joints of 42 human cadavers with the naked eye, and measured the shape of the articular surface of the patella, the degenerative situation of the joint cartilage, the thickness of the cartilage, and the quadriceps-angle. Anatomical factors, such as the shape of the patellar articular surface, the thickness of the joint cartilage, the greater Q-angle and weakness of the quadriceps femoris muscles, were closely related to the degeneration of the PF joints in females. From these results, we consider that many elderly females may have problem with the patellofemoral joints. Therefore, it is important to carefully instruct these patients with regard to exercise and training.

Introduction

The patellofemoral joint or PF joint is a special joint which increases the extension power of the knee joint by converting the tension of the quadriceps femoris muscle. There is great stress on the PF joint when the knee joint is extended. Therefore, the PF joint is covered with a thick cartilage to reduce the stress. However, deterioration of this joint and degeneration of the articular cartilage of the patella was observed in many

cases.

Degeneration of the PF joint was reported for the first time by Budinger¹⁾. Jackson²⁾ classified the causes of this disease biomechanically and biochemically. Morscher³⁾ and Outerbridge⁴⁾ showed that anatomical variations such as the shape of the patella were the cause of the disease and Insall suggested that disturbances in the alignment such as the quadriceps-angle, Q-angle, were the cause.

In this study, we examined 84 PF joints of 42 human cadavers with the naked eye, and

measured the shape of the articular surface of the patella, the amount of degeneration in the joint cartilage, thickness of the cartilage, and the Q-angle.

Materials

We used 84 knee joints of 42 human cadavers for systematic anatomical dissection training. The average age was 76. The cadavers underwent arterial embalming to maintain flexibility and organic structure.

Methods

The shapes of the articular surface of the patella were classified into three grades according to the classifications of Wiberg⁵⁾. In Type I, the size of the lateral side of the joint is almost equal to that of the medial side. In Type II, the lateral side is larger than the medial side. In Type III, the incline of the medial side of the joint is very steep and convex (Fig. 1).

The state of degeneration of the joint cartilage of the patella and femur was classified into four stages, normal, slight, moderate, and serious degeneration, according to the classifications of Oshida⁶⁾ (Table 1).

The thickness of the patella joint cartilage without degeneration of the articular surface was measured in 39 cases. Five areas were measured: the center of the medial portion, the most medial portion, the center of the

lateral portion, the most lateral portion, and the center of the protuberant portion. The thickness of the femoral joint cartilage without degeneration of the articular surface was also measured in 50 cases. Four areas were measured: the center of the medial portion, the center of the lateral portion adjacent to the patella, the center of the medial portion and the center of the lateral portion adjacent to the tibia.

Sections of joint cartilage approximately 1 mm wide and 3 mm long were removed with a scalpel. The thickness was measured with a vernier caliper.

Lastly, the Q-angles were measured.

There were 60 cases in which the Q-angles could be measured without flexor contracture of the knee joints. Pins were placed at anterior superior iliac spine, the center of the patella and the tibial tuberosity. Thread was strung between the pins, and the angles were measured with a goniometer.

We used the student t test for statistical analysis.

Results and discussion

Observations of the shape of the articular surface of the patella in males showed Type I in 10 cases. Of these cases, degenerating cartilage was observed in the medial part in

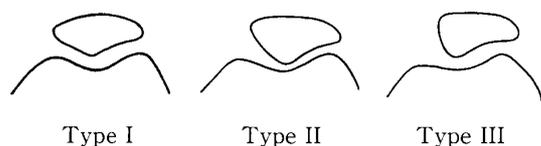


Fig. 1 Classification of Wiberg⁵⁾

In Type I, the size of the lateral side of the joint is almost equal to that of the medial side. In Type II, the lateral side is larger than the medial side. In Type III, the incline of the medial side of the joint is very steep and convex.

Table 1 Degeneration State Classification of Oshida⁶⁾

Normal	: Slight discoloration without peeling off of cartilage
Slight	: Peeling off, fine split and 1cm diameter ulcer below cartilage
Moderate	: Deep peeling off and almost 1cm in diameter exposure of hypochondylage bone
Serious	: Exposure of hypochondylage bone covers a wide area

four cases. Type II was found in 33 male cases. Twenty-two of these cases had a normal articular surface. Among the 11 cases that had degeneration, eight cases had partial or slight degeneration, but three cases had wide areas of moderate degeneration. Type III was found in three cases. Degeneration was observed in the cartilage of the patellar joint in all three cases.

In females, Type I was observed in five cases. Slight degeneration in the medial area was found in two cases and moderate and general degeneration was observed in one case. Type II was found in 26 cases. Only nine of these cases had normal articular cartilages. All seven cases in Type III had wide areas of moderate or serious degeneration of the cartilage. We concluded that incongruities in the articular surface brought about degeneration in the Type III cases (Table 2).

Many patellar cartilages degenerated bilaterally in females (Table 3). These results were in agreement with our clinical experiments.

We studied the relationship between the patellar joint cartilage and the femoral joint cartilage of the patellar side. Normal articular cartilage of both the patellar and femoral sides was observed in 25 male and 8 female cases, a total of 33 cases. Degenerative articular cartilage of both the patellar and femoral sides was observed in 8 male and 20 female cases, a total of 28 cases. Degenerative articular cartilage of only the patellar side was observed in 10 male and 7 female cases, a total of 17 cases, while degenerative

articular cartilage of only the femoral side was observed in 3 male and 3 female cases, a total of 6 cases (Table 4).

Table 2 Relationship between shape of the surface of the patella and degenerative cartilage

	state	area	Type I	Type II	Type III	
Male	Normal		6	22	0	
	Slight	Medial	0	4	0	
		Central	0	2	0	
		Lateral	0	1	0	
		Whole	0	1	0	
	Moderate	Medial	0	0	0	
		Central	0	0	0	
		Lateral	0	0	0	
		Whole	1	3	1	
	Serious	Medial	1	0	0	
		Central	0	0	0	
		Lateral	1	0	0	
		Whole	0	0	1	
	Female	Normal		2	9	0
		Slight	Medial	2	3	0
			Central	0	0	0
Lateral			0	1	0	
Whole			0	3	0	
Moderate		Medial	1	1	1	
		Central	0	0	0	
		Lateral	0	0	0	
		Whole	0	6	1	
Serious		Medial	0	1	0	
		Central	0	0	0	
		Lateral	0	0	0	
		Whole	0	3	5	

Table 3 Laterality of the degeneration of the cartilage of the patella

	Unilateral	Bilateral
Male	4	7
Female	5	11

Table 4 Relationship between the patellar joint cartilage and the femoral joint cartilage of the patellar side

	Both normal	Patella only	Femoral only	Both degeneration
Male	25	10	3	8
Female	8	7	3	20

We measured the average thickness of each Type of cartilage. The articular cartilage of the patellar area in males was significantly thicker than that in females ($p < 0.05$), but there was no significant difference in the femoral area. In males, the articular cartilage of the patellar area was significantly thicker than that of the femoral area ($p < 0.05$). The center of the lateral portion of the articular cartilage of the patella was significantly thicker than that of the medial portion in both males and females ($p < 0.05$) (Table 5).

Q-angles were measured in 35 male cases and 24 female cases. The mean of the Q-angles was 15.0 degrees in males, and 16.9 degrees in females. These angles were consistent with the measurements of other researchers⁷⁾⁸⁾. This difference was significant ($p < 0.05$). The mean of the Q-angles of the normal group was 14.7 degrees (14.2 degrees in males, 16 degrees in females), while that of the degeneration group was 16.9 degrees (16.2 degrees in males, 17.4 degrees in

females). This difference was also significant ($p < 0.05$) (Table 6). The Q-angle has been closely associated with osteoarthritis of the knee joint. However, examination of greater numbers of cases in more detail is required.

We believe that the difference in the thickness of the articular cartilage of the patella between males and females is caused by a difference in the muscle strength of the quad-

Table 6 Mean of the Q-angles

	Male	Female	Whole
Whole	15.0±3.4	16.9±3.9	15.8±3.7
Normal	14.2±2.7	16.0±3.1	14.7±2.9
Degeneration	16.2±4.3	17.4±4.3	16.9±4.2

*: $p < 0.05$ (degrees)

Normal : Normal of the articular cartilage of the patella
 Degeneration: Degeneration of the articular cartilage of the patella

Table 5 Average thickness of each portion of the cartilage

	Patellar side					Femoral side			
	LL	LM	PRO	MM	ML	LP	LT	MP	MT
Male	3.7±0.9	3.5±0.9	3.2±0.8	3.0±0.7	3.1±0.6	2.4±0.4	2.0±0.4	2.4±0.6	2.1±0.4
Female	2.5±0.4	2.7±0.6	2.4±0.5	2.2±0.6	2.2±0.5	2.1±0.3	1.8±0.4	2.2±0.5	1.8±0.5

*: $p < 0.05$ (mm)

Patellar side

LL : The most lateral portion

PRO: The center of the protuberant portion

ML : The most medial portion

LM : The center of the lateral portion

MM : The center of the medial portion

Femoral side

LP : The center of the lateral portion against the patella

LT : The center of the lateral portion against the tibia

MP : The center of the medial portion against the patella

MT : The center of the medial portion against the tibia

riceps femoris. We found serious degeneration in many PF joints. Anatomical factors, such as the shape of the patellar articular surface, the thickness of the joint cartilage, the greater Q-angle and the weakness of the quadriceps femoris muscles were correlated

to the degeneration of the PF joints in females. From these results, we conclude that many elderly females may have disturbances of the PF joints. Therefore, it is important to carefully instruct these patients with regard to exercise and training.

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