THE ETIOLOGY OF CHONDROMALACIA PATELLAE

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A study of the literature on chondromalacia of the patella shows that its etiology is ill understood. Most writers have been willing to accept injury as its cause without much question. I have long been interested in this problem, and for some years I have been in the habit, when excising a semilunar cartilage, of carefully observing and recording the condition of the articular cartilage on the deep surface of the patella. In 196 cases of medial meniscectomy the number of patellae showing healthy articular cartilage was approximately equal to the number showing pathological change (Table I). This is a lower incidence of chondromalacia than that reported by many other writers. Wiles, Andrews and Devas (1956) stated that chondromalacia patellae " often begins during the second decade, and by the age of thirty nearly everyone is affected." Øwre (1936) examined 124 patellae at necropsy and found a high incidence of abnormal cartilage: of subjects over twenty years of age, ninety-seven out of 106 showed pathological changes.

Thus it must be accepted that chondromalacia of the patella is far more common than is generally believed, because usually it does not cause symptoms.

TABLE I

INCIDENCE OF CHONDROMALACIA OF THE PATELLA OBSERVED AT MENISCECTOMY

Age in years	Number of cases	Articular cartilage of patella	
		Normal	Abnormal
12–19	24	12	12
20–29	48	31	17
30–39	61	34	27
40–49	42	12	30
50–59	18	5	13
60–69	3	1	2
Total . .	196	95	101

MACROSCOPIC CHANGES IN CHONDROMALACIA PATELLAE

The normal appearance of healthy hyaline cartilage of the deep surface of the patella is bluish-white, smooth, glistening and resilient. The earliest change in chondromalacia is that the cartilage becomes dull or even slightly yellowish-white, and is soft and swollen. Characteristically, the site is almost always in the middle of the medial patellar facet, or just distal to that point, and is about half an inch or more in diameter (Fig. 1).

As the condition progresses, irregular deep fissures develop, and the affected area becomes a mass of villous-like cartilaginous flakes attached to subchondral bone (Fig. 2). This area gradually increases in size while at its centre the cartilage is eroded down to bare bone. Gradually the changes extend to the lateral facet, usually crossing the waist of the bone (Fig. 3) until the whole patella is affected.

The cartilage of the femoral condyles is not usually involved, with two exceptions. The first is the occasional " mirror " area of erosion usually seen in the intercondylar area (Fig. 4) in patients with advanced patellar changes or with generalised osteoarthritis of the knee;

and the second is the not infrequent erosion of the upper border of the medial femoral condyle, which will be discussed later.

These macroscopic changes of chondromalacia of the patella can be classified into four grades: in grade 1 there are softening and swelling of the cartilage; in grade 2 there are fragmentation and fissuring in an area half an inch or less in diameter; grade 3 is the same as

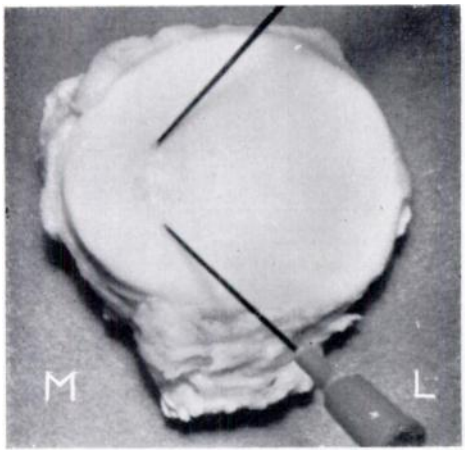

FIG. 1

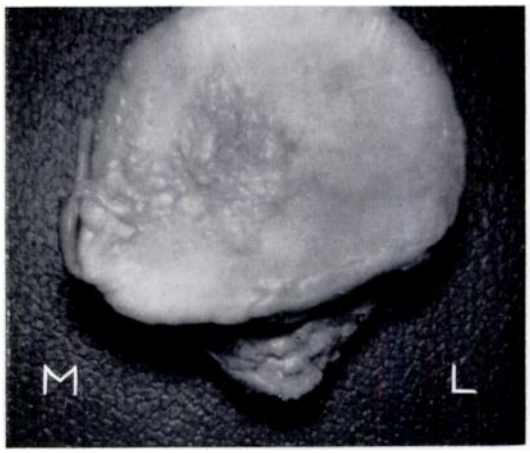

FIG. 2

Figure 1—The points of the needles show the edges of the chondromalacia at an early stage. Figure 2—The advanced fibrillar changes on the medial facet are spreading to the lateral side.

FIG. 3

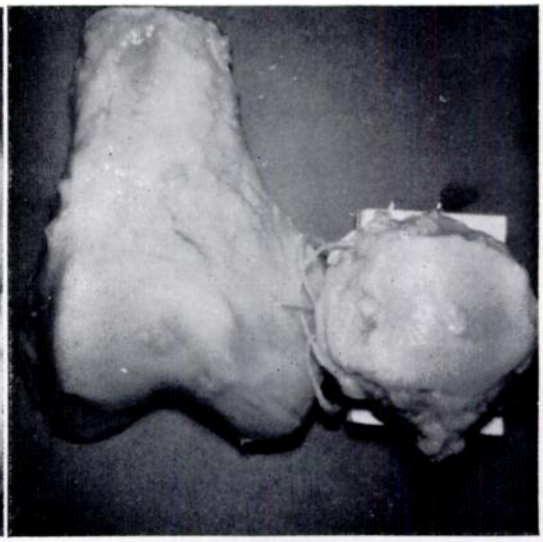

FIG. 4

Figure 3—The erosion is down to the subchondral layer medially, and has spread across the mid line.
Figure 4—The medial facet of the patella is badly eroded, and there is a " mirror area " on the intercondylar area of the femoral condyles.

grade 2 but an area more than half an inch in diameter is involved; in grade 4 there is erosion of cartilage down to bone (Table II).

There appears to be no relationship between the time or severity of the injury causing the tear of the meniscus and chondromalacia of the patella. In this series there were seventy-eight " bucket handle " tears of the meniscus, and Table III shows that only thirty-seven of these were associated with chondromalacia of the patella, which was usually not severe.

THEORIES OF THE ETIOLOGY OF CHONDROMALACIA PATELLAE

In the literature various and inconclusive theories fall into three main groups.

Injury—This is the most popular theory. Some authors did not specify the type of injury (Axhausen 1919, Büdinger 1906), others suggested a direct injury (Chaklin 1939) or an indirect twist (Cave, Rowe and Yee 1945).

Generalised constitutional disturbance—An endocrine or toxaemic condition was suggested by Hinricsson (1939), but others believed that it was a combination of injury with an underlying constitutional tendency to cartilage degeneration (Kulowski 1933, Karlson 1940).

TABLE II

THE SEVERITY OF CHONDROMALACIA OF THE PATELLA SEEN AT MENISCECTOMY RELATED TO THE AGE OF THE PATIENT

Age in years	Number of cases	Grade of chondromalacia			
		1	2	3	4
12–19	12	8	1	2	1
20–29	17	6	6	2	3
30–39	27	7	12	6	2
40–49	30	9	13	6	2
50–59	13	3	5	3	2
60–69	2	—	1	—	1
Total . .	101	33	38	19	11

TABLE III

ASSOCIATION BETWEEN "BUCKET HANDLE" TEARS OF THE MENISCUS AND CHONDROMALACIA OF THE PATELLA

Age in years	Number of cases with bucket handle tears	Normal patellae	Grade of chondromalacia			
			1	2	3	4
12–19	9	5	3	1	—	—
20–29	22	15	2	2	2	1
30–39	29	17	4	6	2	—
40–49	14	3	3	6	1	1
50–59	3	—	2	1	—	—
60–69	1	1	—	—	—	—
Total . .	78	41	14	16	5	2

Patello-femoral contact—Wiberg (1941) investigated the congruity between the deep surface of patella and the femoral condyle at different angles of flexion, starting at 30 degrees of flexion. He found that the lateral patellar facet was concave in two planes and was in close contact with the lateral femoral condyle throughout most of the range of joint movement, but that the medial patellar facet was convex and only touched the medial femoral condyle with a small portion of its surface. He also found that contact between patella and femoral articulation is close at the beginning of flexion, but that this contact slowly passes outward

on to the medial and lateral facets of the patella with further flexion; in some specimens flexed beyond 90 degrees Wiberg observed that " incipient chondromalacia was seen precisely at the point of contact between the medial facet and the medial femoral condyle " which he felt was a proof that the stress over this small area of contact was likely to lead to chondromalacia.

Before any theory on the etiology of chondromalacia of the patella can be accepted, its great frequency, particularly after the age of thirty, and its common site of origin on the medial facet must be explained.

It is unlikely that any of the theories outlined above explains the etiology fully. Many patients, such as those reported in this paper, have no specific history of injury, nor does it seem possible that the mild and often repeated but quickly forgotten injuries to which the patella is vulnerable should be the cause of this condition, because other joints, such as the ankle, are subjected to far greater abuse without disintegrating. It also seems unlikely that a constitutional disturbance should make the medial patellar facet more susceptible to injury.

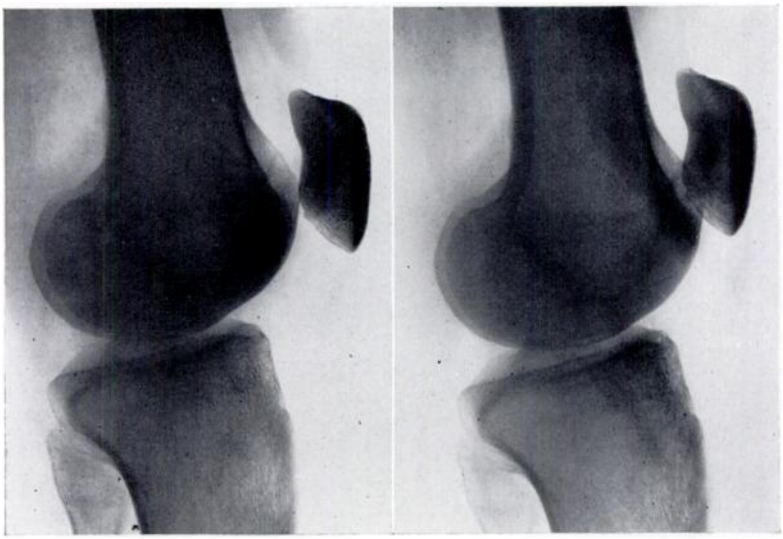

FIG. 5 FIG. 6

The quadriceps muscle is relaxed in Figure 5, but in Figure 6 the contracting quadriceps muscle has pulled the patella up and against the femoral shaft.

It has been suggested that the nutrition of the patellar articular cartilage, which is the thickest in the body, is at fault, but if this were so the degenerative changes should begin in the central ridge where the thickest cartilage is actually found (Øwre 1936, Wiberg 1941).

It is probable that the concept of pressure or friction in considerable flexion, as outlined by Wiberg (1941), comes closest to explaining the etiology, but flexion to this extent—such as in squatting—is not common in occidentals.

There is one other position, in the first 40 degrees of flexion, in which this particular part of the medial patellar facet is subjected to repeated pressure and friction. When the knee joint is fully extended the patella lies on the surface of the femoral shaft—from which it is separated by a subsynovial fat pad—and almost completely proximal to the crescentic superior border of the femoral articular cartilage. When the quadriceps muscle is relaxed the distal part of the patellar cartilage rests against this border (Fig. 5), but when the quadriceps is contracted the patella is pulled upwards about half an inch and compresses the fat pad and lies entirely over the femoral shaft (Fig. 6).

The crescentic upper border of the femoral articular cartilage extends more proximally on the lateral than on the medial side. Lying just above the lateral upper border, on the

femoral cortex, there is a smooth, whitish area, uncovered by soft tissue, which acts as a skid (Fig. 7) to allow the lateral patellar facet to glide smoothly on to the cartilaginous surface of the condyle; the lateral patellar facet is already well on to the condyle before the medial facet reaches the cartilaginous border of medial condyle.

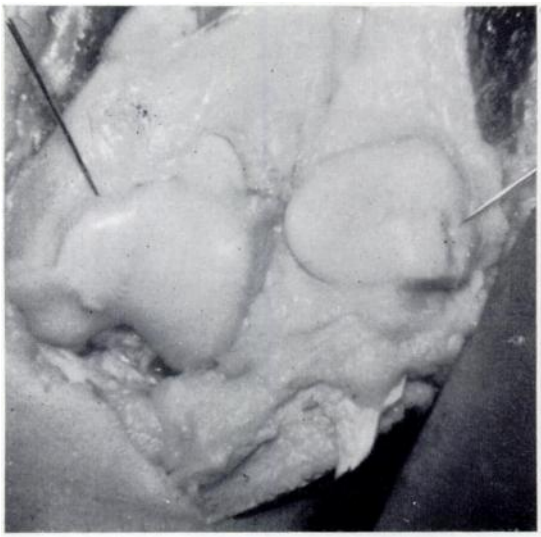

FIG. 7

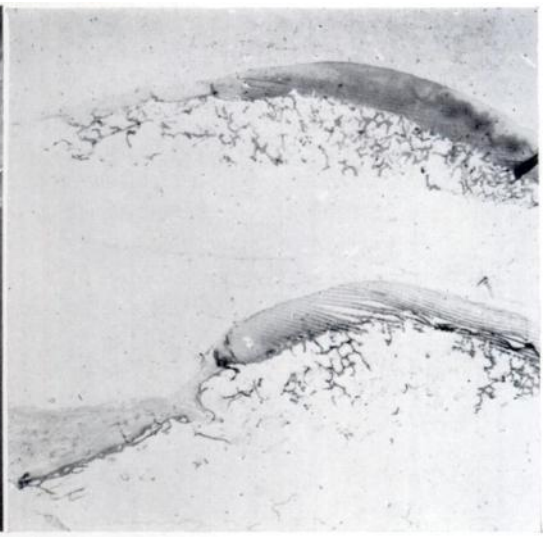

FIG. 8

Figure 7—The probe on the left is directed toward the rim of the thickened superior border of the medial femoral condyle. The " skid area " above the lateral condyle is well demonstrated. Figure 8—Longitudinal sections through the centre of the lateral (above) and medial (below) femoral condyles. Note the smooth continuity of the femoral shaft with the cartilage on the lateral side, and the rim on the medial side.

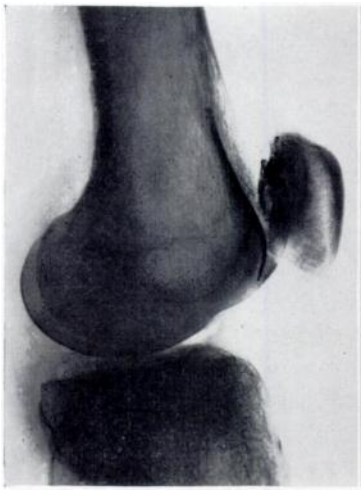

FIG. 9

FIG. 10

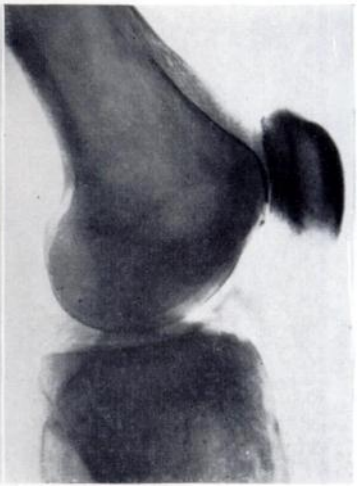

FIG. 11

Radiographs of the surface of medial condyle and medial patellar facet outlined with red lead to show their relationship. Figure 9—At 10 degrees of flexion. Figure 10—At 20 degrees. Figure 11—At 30 degrees.

The crescentic upper border of the medial condyle is quite different from that of the lateral. Here the articular cartilage is separated from the cortex of the anterior femoral shaft by a distinct rim which crosses the full width of the condyle and which may vary in height from three to eight millimetres (Fig. 8). As flexion begins, the patella, instead of sliding smoothly from the shaft on to the surface of medial condyle—as on the lateral side—particularly if the quadriceps muscle is contracted, at first hugs the femoral shaft closely, then

lifts up over the rim (Fig. 9). As flexion continues the patella is dragged across the rim to a point just beyond its centre (Fig. 10) and then tilts down on to the sloping surface of the condyle (Fig. 11). The part of the medial facet principally involved by this shearing force is this same area where the early changes of chondromalacia are seen. The range of movement through which this shearing occurs as the patella is drawn across the rim is from about 15 to 30 degrees of flexion.

This rim was present to a greater or lesser degree in most adult knee joints that were examined. Anatomists are aware of its presence, but it has never been given a name. In Figure 8 are shown longitudinal sections of the lateral and medial femoral condyles, to demonstrate the smooth approach of the former in contrast to the rim of the latter. Examination of knee joints at operation or necropsy has demonstrated that there appears to be a definite relation between the severity of the chondromalacia patellae and the size of this rim.

This theory of the etiology of chondromalacia of the patella has been presented because it is believed that it gives a satisfactory explanation of the pathological findings. However, there are probably other factors in the etiology as well as the size of the rim, such as the size and angulation of the medial, in relation to the lateral, patellar facet, and the power of the quadriceps muscle and its vastus medialis component.

SUMMARY

1. Chondromalacia of the patella starts most frequently on the medial facet.
2. The anatomy of the medial femoral condyle is described, including the rim at its superior border, and the different arrangement at the upper border of the lateral femoral condyle.
3. Rubbing of the medial patellar facet on the rim at the upper border of the medial femoral condyle can explain in part the etiology of chondromalacia.

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