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OSTEOARTHROSIS FOLLOWING INSUFFICIENCY OF THE CRUCIATE LIGAMENTS IN MAN

A Clinical Study

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Based on a series of 48 patients with old untreated ruptures of one or both cruciate ligaments, the development of osteoarthrotic changes was demonstrated by radiography and at operation. The changes were similar to those seen in animal experiments and developed in the same sequence. Osteophytes occurred in knees with anterior cruciate insufficiency after about 2 years; significant osteoarthrotic changes occurred after longer periods, and particularly in knees with damage to both cruciate ligaments.

Key words: cruciate ligaments; gonarthrosis; knee osteoarthrosis

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A matter of current interest to the orthopaedic surgeon is to what degree an untreated rupture of the anterior and/or posterior cruciate ligaments may cause osteoarthrotic changes in the knee joint of man. Section of the cruciate ligaments in experimental animals causes structural changes in the joint cartilage and bone (Magnuson 1941, Hulth et al. 1970, Marshall & Olsson 1971, Bohr 1976) but because the gait and weight-bearing as well as the physical activity in general, and the speed of physiological aging processes, are so different in the joints of animals and man a clinical study of the processes in man may help to elucidate this problem.

PATIENTS AND METHODS

Definition. The term osteoarthrosis is used here to describe a condition in which aseptic destruction of the articular cartilage leads to denudation of the subchondral bone with subsequent structural changes in the form of cysts and sclerosis. To the clinician the essential symptom is pain. To the pathologist destruction of cartilage is a necessary finding (Collins 1949), while to the radiologist the condition is linked first and foremost with narrowing of the joint space and also with the above-mentioned structural changes in the subchondral bone (Ahlbäck 1968). The presence of osteophytes alone cannot be taken as a significant sign of osteoarthrosis (Danielsson & Hernborg 1970).

Patients. All the patients included in the present study were operated on by the author during the years 1972 to 1975. The criterion for inclusion was rupture of one or both cruciate ligaments with symptoms lasting for more than 6 months. The series comprises 48 patients of whom only seven are females. Thirty-six patients were below the age of 30 at the time of operation and 44 patients below the age of 40; the mean age was 28, ranging from 16 to 73. There were no bilateral cases. The type of surgical repair included 33 cases of the Jones' procedure for replacement of the anterior cruciate ligament, seven other kinds of ligament plasty,

Table 1. Findings at operation graded according to Collins. O = no cartilage destruction.

Type of cruciate ligament rupture	Duration of condition	Collins' grade 0	I	II	III	IV	Total no. of patients
Anterior cruciate	½ to < 2 years	13	6	2			21
	2 to 3 years	4	5	2	1		12
	> 3 years	3		6	1		10
Posterior cruciate	1 and 5½ years	1		1			2
Both	2, 17 and 21 years					3	3
No. of patients		21	11	11	2	3	48

three cases of meniscectomy, four explorations and one tibial osteotomy plus debridement of the joint.

Methods. During the operation, a description was made of the injury to the ligaments and menisci and the state of the articular cartilage and the presence of osteophytes was noted. Ahlbäck (1968) recommended radiography of the knee joint during weight-bearing in order to disclose narrowing of the articular space. That this examination is lacking in most of the cases is irrelevant as the pathoanatomy of the cartilage was examined directly during surgery. On the basis of this description the cartilage destruction was graded according to Collins (1949):

Grade I: superficial destruction of cartilage, tangential flaking, early fibrillation and small blisters or grooves. No marginal hyperplasia of bone or cartilage.

Grade II: more extensive cartilage destruction, but still confined to pressure and movement areas and without denudation of bone. Deep fibrillation and marked loss of cartilage substance. Early marginal hyperplasia.

Grade III: denudation and usually eburnation of bone in one or more pressure areas, though regions of unaffected cartilage often remain. Obvious osteophytes at joint margins.

Grade IV: complete loss of cartilage from large areas of the joint surface. Eburnation of exposed bone, epiarticular osteophytes, remodelling of the contour of the bone ends.

Conventional a–p and lateral radiographs were studied for osteophytosis, Felsenreich's sign, i.e., deformity of the tubercles of the intercondylar eminence (Felsenreich 1934) and structural changes, i.e., bone cysts and sclerosis. The healthy knee was used as a control.

In order to use both the radiographical and operative findings as a combined measure of development of osteoarthrosis the suggestions of Hulth (1969) have been followed: As Collins' grade I and II are clinically silent and osteophytes without other X-ray changes are not sufficient to allow a firm diagnosis of osteoarthrosis (Hulth 1969, Danielsson & Hernborg 1970), these groups have been given a different designation on the diagram in Figure 1. Collins' grade III and IV and radiographical findings of structural bone changes, varus deformity or joint space narrowing (as defined by Ahlbäck) have been used as sufficient criteria to allow a firm diagnosis of significant arthrosis (black columns in Figure 1).

The findings were correlated with the duration of knee instability and with the patient's age at onset of symptoms. In addition, earlier meniscectomy was taken into consideration as this could influence development of osteoarthrosis (Johnson et al. 1974).

FINDINGS

The patients were grouped as shown in Table 1: 43 patients with rupture of the anterior cruciate ligament (group 1), two patients with rupture of the posterior cruciate ligament (group 2) and three patients lacking both anterior and posterior ligaments (group 3). It appears from Table 1 that undamaged cartilage became less frequent as the duration of symptoms increased, so it can be assumed that cartilage destruction is a progressing phenomenon in these knees. If only one of the cruciate ligaments is lacking, the process is relatively slow; if both are lacking the process is quick and pronounced—all knees in group 3 belong to grade IV.

Table 2. Radiographical findings. Number of patients with unilateral abnormal findings.

Type of cruciate ligament rupture	Duration of condition	No radiographic abnormalities	Osteophytes	Structural bone changes (cysts, sclerosis) and/or narrowing of joint space	Total no. of patients
Anterior cruciate	½ to < 2 years	19	2		21
	2 to 3 years	5	7	1	12
	> 3 years	2	8	2	10
Posterior cruciate	1 and 5½ years	2	0	0	2
Both	2, 17 and 21 years	0	3	3	3
No. of patients		28	20	6	48

Table 3. Grade of osteoarthrosis according to Collins related to patients' age at injury to cruciate ligaments. 0 = no cartilage destruction.

Age (years)	No. of patients	Patients divided according to Collins' grade of osteoarthrosis				
		0	Grade I	Grade II	Grade III	Grade IV
< 20	12	6 (50 %)	3 (25 %)	3 (25 %)	0	0
20–30	30	14 (47 %)	6 (20 %)	8 (27 %)	2	0
31–40	3	0	2	0	0	1
> 40	3	1	0	0	0	2
Total	48	21	11	11	2	3

Among the 16 patients in group 1 with cartilage wear of grade I–III and up to 3 years since onset of the condition, meniscal damage, or previous meniscectomy, was found in eight, or half of them. In those with duration longer than 3 years, 7 out of 10 had meniscus injury or an earlier removed meniscus in combination with anterior cruciate ligament insufficiency. Five of these had cartilage wear grade II–III; two had none at all. Of the three patients with intact menisci, two had grade II cartilage wear and one had none. In group 3 all had osteoarthrosis grade IV—one of them with intact menisci. The importance of this will be discussed.

In Table 2 the radiographical findings are shown, the same grouping of the patients being used. The radiographical signs progress at a somewhat slower rate but in full accordance with the pathoanatomical changes.

Table 3 shows the grade of osteoarthrosis related to the age at injury. No conclusions can be drawn from this, as nearly all the patients were below 30 at the onset of symptoms and the very few older patients (6) include the three with rupture of both cruciate ligaments and, in addition, the collateral ligaments and among these are two with very long-lasting symptoms. They have all odds against them and have all developed a grade IV arthrosis.

A summary of the essential results is presented in Figure 1. This bar chart illustrates the increase in incidence and severity of osteoarthrosis as the interval from the time of the original injury increases.

A finding not earlier described in the

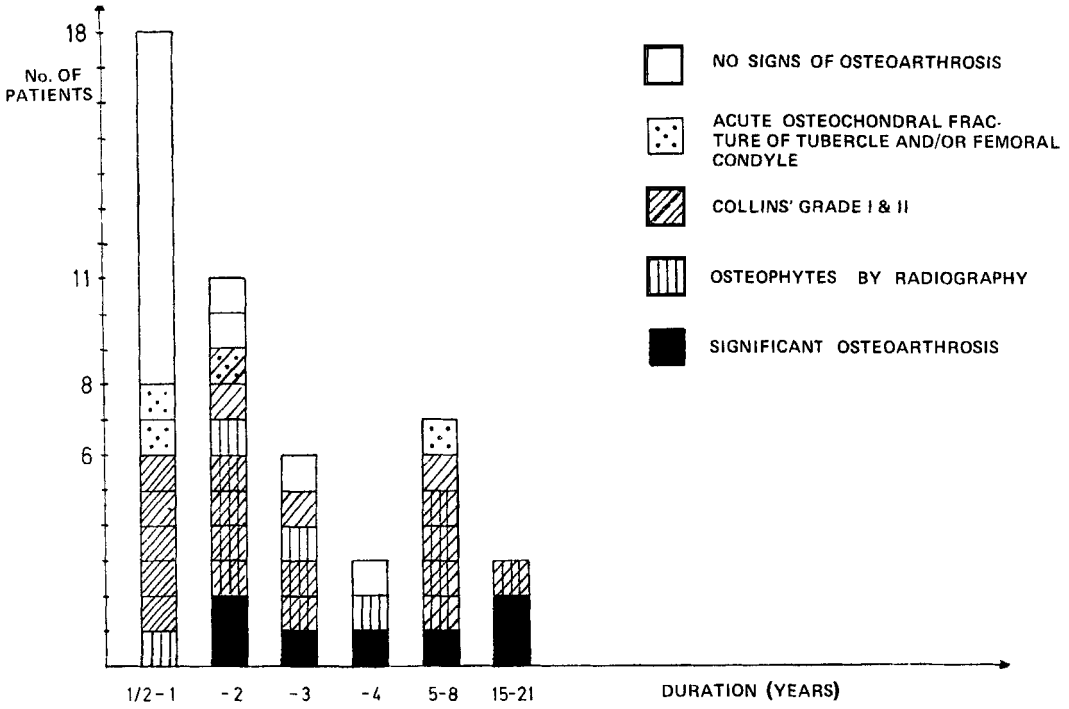


Figure 1. Duration of insufficiency of cruciate ligaments related to osteoarthrosis in 48 patients. Significant arthrosis means that the knee was classified as Collins' grade III or IV and/or showed structural changes such as cysts or bone sclerosis, varus deformity or joint space narrowing at radiography. The uninjured knee was normal.

literature is included in Figure 1. At operation an acute osteochondral fracture of the medial tubercle was found in four knees, with an associated osteochondral fracture of the latero-distal aspect of the medial femoral condyle in two knees. Presumably these small fractures are sustained by compression or "cutting" when the two surfaces mentioned contact each other during a sudden subluxation in the unstable knee.

In the three patients with rupture of both the anterior and posterior cruciate ligament and one of the collateral ligaments (group 3), osteophytes, structural bone changes and narrow joint space were shown at radiography. At operation large osteophytes together with widespread denudation of bone were found. In one of these patients the changes developed in the course of 2 years (Figure 2), in another after 17 years. The third patient was a woman of 73 years with an osteoarthrotic varus deformity caused by 21 years of knee instability. The deformity was corrected by an osteotomy. Her other knee was completely normal (Figure 3).

DISCUSSION

Danielsson & Hernborg (1970) have shown that knee joints with osteophytes in the tibiofemoral joint do not necessarily develop structural changes. They do not mention drawer sign or collateral looseness, so one must expect that such patients were excluded from their study.

In studies on dogs after transection of the anterior cruciate ligament in one knee, Marshall (1969) and Marshall & Olsson (1971) found rapid osteophyte-

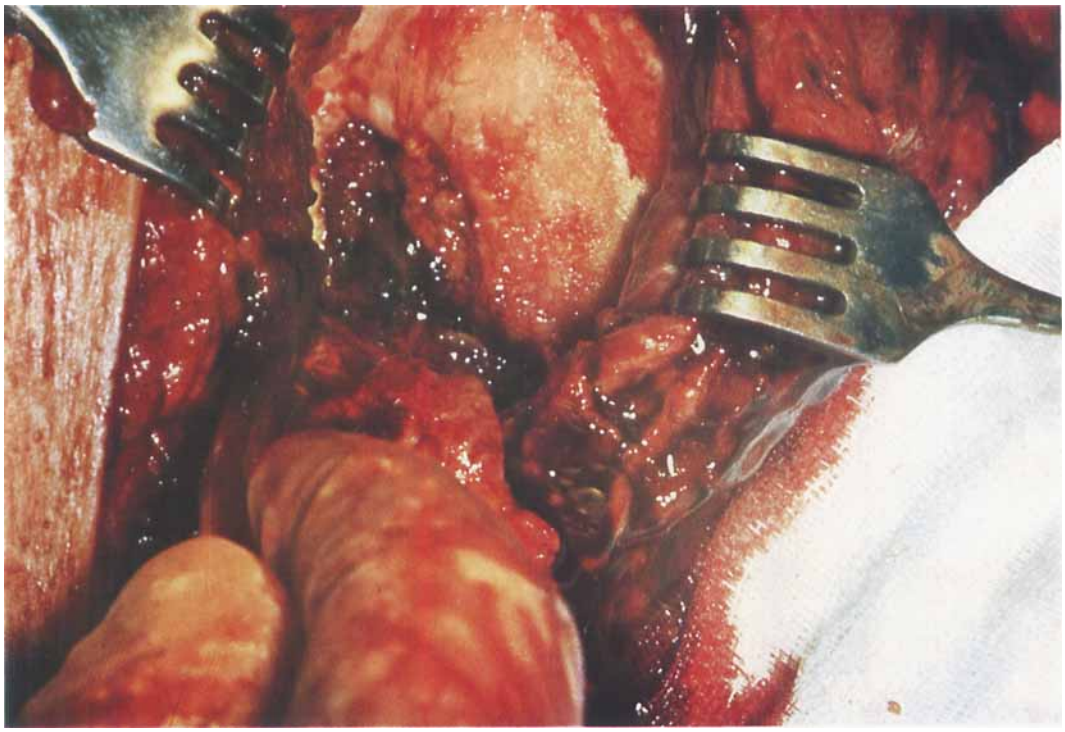


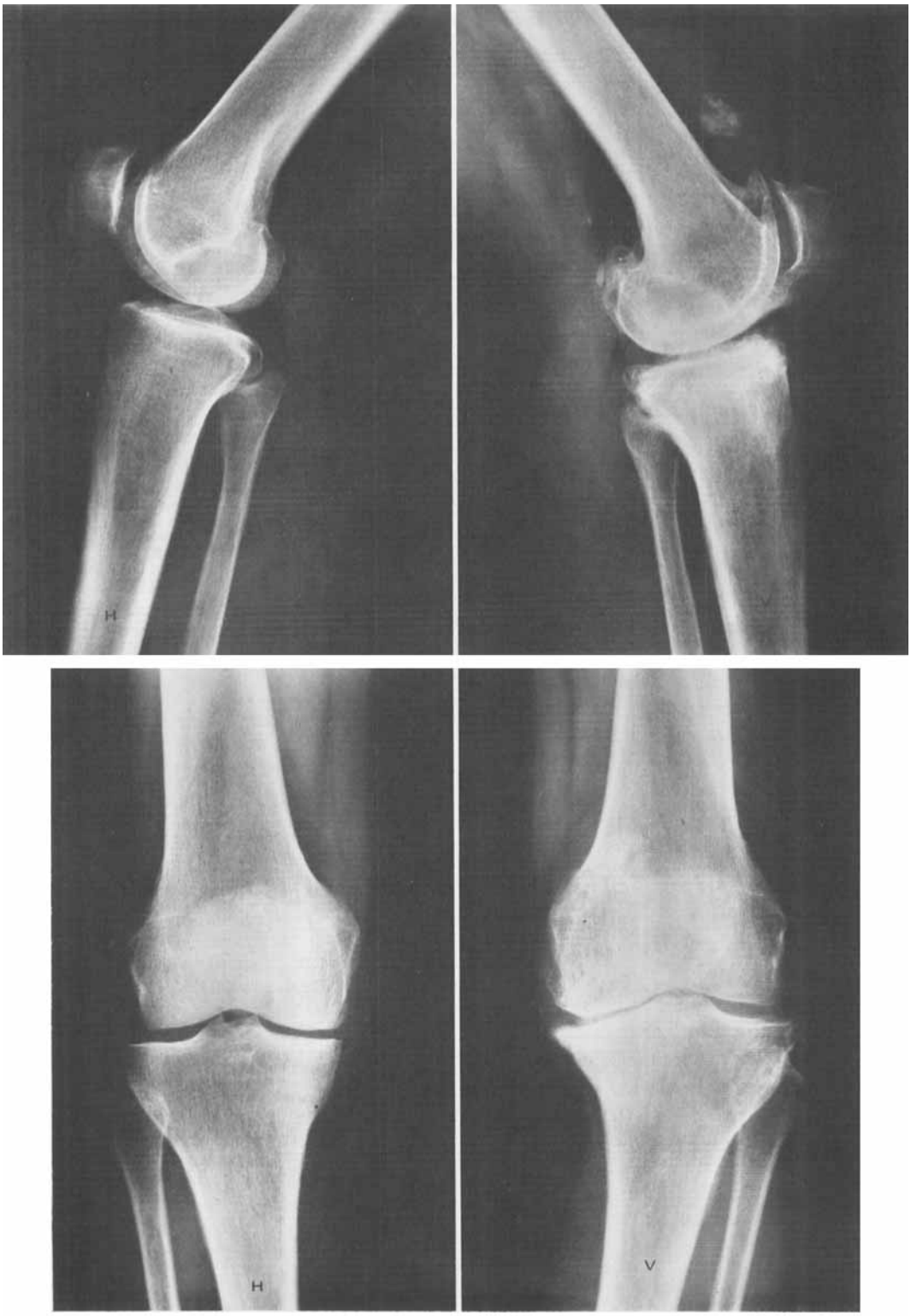
Figure 2. Photograph from the operation of a 49-year-old man with total rupture of both cruciate ligaments and the medial collateral ligament. Duration of knee instability only 2 years. Note destruction of articular cartilage, which was found on all the articular surfaces of the joint. Here only the medial femoral condyle is visible. Note also the marked thickening of synovial membrane and fibrous joint capsule.

formation in the unstable knee, but no subchondral structural changes (cysts or bone sclerosis), even after longer observation periods. They conclude, as do Danielsson & Hernborg, that osteophytes are not necessarily a sign of degenerative lesions in the cartilage, and that the diagnosis of osteoarthrosis should not be made solely on the presence of osteophytes.

From the results of these investigations it is not known whether the changes caused by unstable knees in the dog—and in man—are of a proliferative type only or if they are a precursor to, and may develop into, a significant osteoarthrosis.

That many patients with unstable knees over the years develop an advanced osteoarthrosis has been stressed by Liljedahl et al. (1965). This is in accordance with Collins' (1949) suggestion that the initial lesion of osteoarthrosis is destruction of articular cartilage. Such destruction seems apt to develop as a consequence of repeated major and minor traumas caused by the numerous subluxations in unstable knees. Recently

Figure 3. Lateral and antero-posterior radiographs of a 73-year-old woman with an unstable left knee (V). The condition had been present for 21 years. At operation, total atrophy of both cruciate ligaments and valgus instability was found. The right knee (H) was normal. Left knee with osteophytosis and bone sclerosis also in the femoro-patellar joint. Loosened cartilage pieces have formed free bodies. Left femorotibial joint with almost completely obliterated joint space, bone sclerosis and compression causing varus deformity.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Bohr (1976) produced experimental osteoarthrosis in the rabbit knee joint by section of both cruciate ligaments and removal of the medial meniscus using the method of Hulth et al. (1970). Within 10 months these animals developed changes in the joint cartilage and subchondral bone of the same severity as those found in advanced osteoarthrosis in man.

The findings in the present series are in good agreement with the experimental results mentioned above. If only one of the cruciate ligaments is ruptured many years may pass before significant osteoarthrotic changes develop even though progressive destruction of cartilage does occur over the years. In severe clinical injuries, however, with rupture of both cruciate ligaments—comparable to the experimental injuries produced in rabbits by Bohr (1976)—advanced osteoarthrotic changes do develop in a relatively short time.

The question of how a meniscus injury or meniscectomy may influence this course was investigated by Johnson et al. (1974). They suggested that meniscectomy could cause osteoarthrosis over a period of many years. Unfortunately his material was not specific as cases of associated cruciate ligament rupture were fairly frequent. This is due to the fact that these injuries very often are combined as they were in the series presented above. In the present series, however, 10 patients with cartilage destruction of grade I to III and one patient of grade IV had intact menisci, which suggests that the menisceal factor is not essential, although it may be a contributory factor. This is also the opinion of Johnson et al. (1974).

It may be concluded that osteophytes and pathoanatomical lesions of Collins' grade I and II are likely to develop within about 2 years in knees with anterior cruciate ligament rupture. Significant arthrosis can develop after longer periods, especially in cases of rupture of both cruciate ligaments with gross instability. An additional meniscus lesion or removed meniscus may accelerate the process.

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