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TIBIAL CONDYLAR FRACTURES AS A CAUSE OF DEGENERATIVE ARTHRITIS

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Most surgeons believe that fractures involving a weight-bearing joint surface under certain circumstances lead to the development of secondary osteoarthritis. There is disagreement, however, on the frequency by which these changes occur, and precise information is lacking about the initiating factors.

Some authors claim that symtom-yielding osteoarthritis is of rare occurrence (Hultén 1929, Slee 1955, Apley 1956, Fryjordet 1967). Others admit that the condition is seen in a certain number of cases (Hohl & Luck 1956, von Bahr 1945, Barrington et al. 1965). The view that exact anatomic reduction is the only way to prevent secondary osteoarthritis is held by some (Palmer 1951, Jakobsen 1953, Rombold 1960, Courvoiser 1965).

A detailed clinical analysis founded on well-defined diagnostic criteria, discussing frequency, age and sex of the patient, correlation to type of fracture, malalignment, residual deformity, instability and functional end result, is not available. Neither do we know the length of the interval between trauma and the development of symtom-yielding osteoarthritis. It is the purpose of the present paper to discuss these problems, which are of great therapeutic and prognostic importance and are also significant in the estimation of disablity compensation following these injuries.

MATERIAL AND METHODS

During the period 15 October 1959 to 31 December 1965, a total number of 260 cases of tibial condylar fractures were treated as in-patients in the Department of Orthopaedic Surgery I.

A comprehensive study of the entire series was undertaken (Rasmussen 1971), but only details relevant to the present subject will be discussed here.

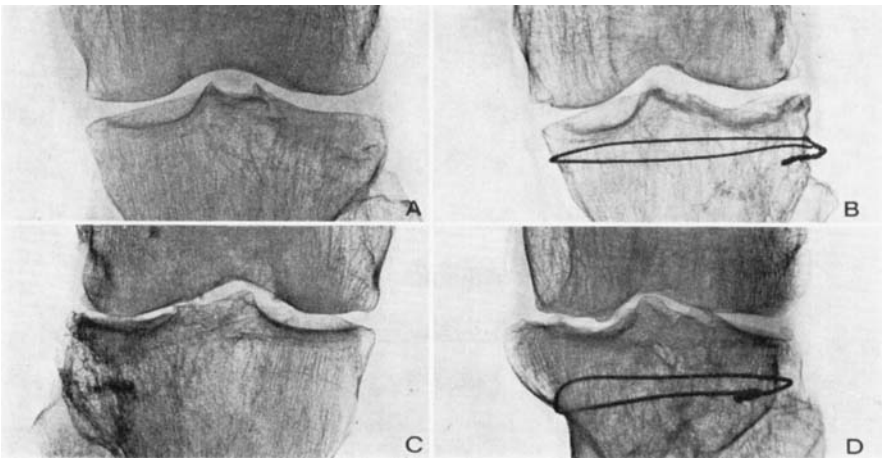

Figure 1. Grading of osteoarthritis following tibial condylar fractures. A. Not present: No changes. B. Doubtful: Irregularity of joint surface, small marginal osteophytes. C. Moderate: Lowering of joint space and marginal osteophytes. D. Severe: Lowering of joint space associated with subchondral sclerosis and marginal osteophytes.

Follow-up Study

Of the total series of patients 78 per cent (204/260) have been clinically re-examined 4–11 years after the injury. The average follow-up period was 7.3 years.

Of the 204 patients clinically examined, 192 were submitted to radiological examination, comprising frontal and lateral views with the patient supine and standing. To this were added two oblique views of the injured knee in 45° outward and inward rotation. Both knee joint were examined in 162 cases. In the remaining 30 only the injured joint was X-rayed.

Radiological Grading of Osteoarthritis

In grading the degenerative changes I have used the criteria introduced by Ahlbäck (1962) in which the main emphasis is laid on the radiological evaluation of a narrowing of the joint space. According to Ahlbäck's study and even that of Danielsson & Hernborg (1970), the appearance of osteophytes and irregularities of the joint surface, often present after tibial condylar fractures, is of little diagnostic significance. The initial radiological change that indicates a process of degenerative arthritis is a narrowing of the joint space. In the early stage this may best be demonstrated when the patient is examined in the standing position. As the cartilage destruction increases, the narrowing appears even in the supine position, and in the more advanced stage of osteoarthritis, sclerosis develops in the subchondral bone.

Based on these principles I classified my cases into four groups: (A) not present. (B) doubtful, (C) moderate and (D) severe.

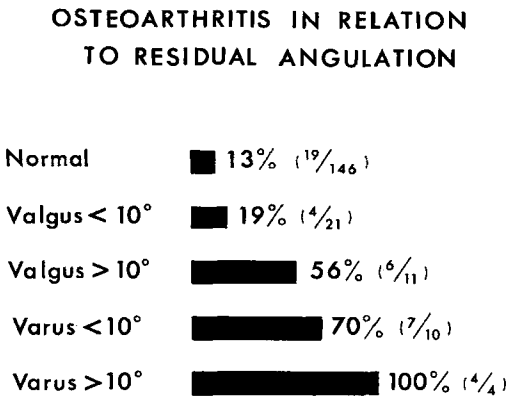

Figure 2. Correlation between osteoarthritis and residual malalignment of the knee joint.

Group A

Not present (Figure 1 A): This group included cases in which no degenerative changes could be demonstrated. Slight sharpening of the intercondylar eminence and insignificant small marginal osteophytes were also included in this group.

Group B

Doubtful (Figure 1 B): To this group I referred cases with marginal osteophytes of a more impressive character, but at the same time cases in which no proof of cartilage destruction could be found. In order not to get too small figures for statistical analysis, I added the groups not present and doubtful together into one, in which no certain evidence of osteoarthritis exists.

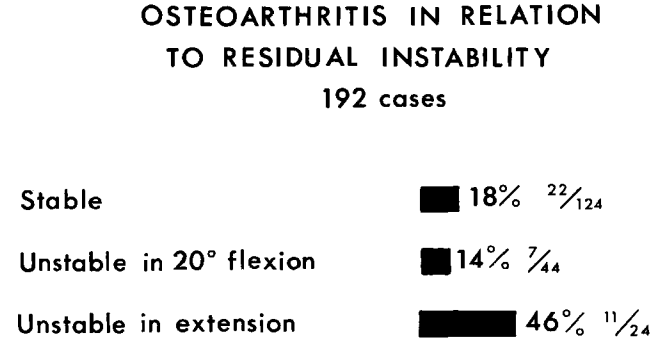

Figure 3. Correlation between osteoarthritis and residual instability of the knee joint.

Group C

Moderate (Figure 1 C): This group included all cases in which narrowing of the joint space could be demonstrated in either supine or standing projections, but at the same time cases in which no subchondral bony changes were found.

Group D

Severe (Figure 1D): This group included all cases in which the lowered joint space was associated with subchondral sclerosis. In the statistical analysis the groups moderate and severe were considered under one heading of cases, in which evidence of osteoarthritis existed.

Two experienced X-ray technicians assisted in making the radiograms. The frontal views in supine and standing positions were accepted only when the tibial joint surface was cut tangentially. In about 2 per cent of the cases this was impossible to attain, because of the different inclination of the lateral and medial plateaus present as a consequence of the fracture. In a similar number of cases the lateral femoral condyle was located in a central defect created by the fracture of the opposing tibial plateau. This too will render difficult the estimation of the joint space. In such cases the observation was considered doubtful, and if no sclerosis existed the case was classified in group A. Another difficulty I met with in a few cases was the estimation of the subchondral sclerosis, particularly in the lateral joint compartment. Many of the patients were treated with bone transplantation and a certain sclerotic structure may remain as a consequence of that. The appearance of sclerosis in the medial compartment was much easier to confirm, because the medial condyle was often fractured in one single block without injury to the medial joint surface and subchondral area.

Table 1. Incidence osteoarthritis in relation to type of fracture.

	Entire series	Osteoarthritis	
	No. of cases		Percent
Lateral	136	21	16
Medial	23	5	21
Bicondylar	33	14	42
Total	192	40	21

RESULTS

Frequency (Table 1)

Of the radiologically re-examined patients 21 per cent (40/192) revealed definite osteoarthritic changes in the injured knee joint. This incidence differed somewhat within the groups of lateral, medial and

bicondylar frectures with 16 per cent (21/136) in the lateral, 21 per cent (5/23) in the medial and 42 per cent (14/33) in the bicondylar group. The difference between the three groups is statistically significant ($X^2 = 11.74$. $p < 0.01$). In 2 per cent (4/192) osteoarthritic changes were found also in the initial X-ray of the injured knee and in another 2 per cent (3/162) follow-up examination revealed such changes even in the opposite uninjured knee. *Thus the true incidence of osteoarthritis, which may be regarded as secondary to the fracture, was between 17 and 21 per cent.*

Age and Sex

No difference was found in the age distribution among patients with arthritis and those of the entire series. The mean age was 53 and 55 years respectively. Men dominated in the osteoarthritis series with 63 per cent compared to 55 per cent in the entire series.

Correlation to Malalignment (Figure 2)

In cases with normal alignment the incidence of osteoarthritis was 13 per cent (19/146); this incidence increased to 31 per cent (10/32) in cases of valgus angulation, with a further step rise to 79 per cent (11/14) in patients with varus angulation. There were four cases with a varus angulation exceeding 10°, two had moderate and two severe osteoarthritis changes. *This increasing incidence of osteoarthritis from normal over valgus to varus angulation is statistically significant* ($X^2 = 25.82$. $p < 0.01$).

Correlation to Residual Instability (Figure 3)

The clinical follow-up included an examination of the lateral stability of the injured knee joint. A distinction was made between instability in extension and instability in 20° flexion. Normal stability was found in 124 cases. In 18 per cent (22/124) of these, follow-up X-rays revealed moderate or severe osteoarthritis. Instability in slight flexion with well-preserved stability in extension was found in 44 patients, 14 per cent (7/44) of whom had osteoarthritis. 11 patients revealed instability of the extended knee joint, 46 per cent (11/24) of those had osteoarthritis. *The high incidence of osteoarthritis in the patients with residual instability of the extended knee joint is statistically significant* ($X^2 = 10.46$. $p < 0.01$).

Table 2. Relationship between posttraumatic deformity and osteoarthritis.

	Entire series No. of cases	Osteoarthritis Percent
No deformity	130	22	17
Depression of joint surface exceeding 5 mm	60	17	29
Condylar widening exceeding 5 mm	7	4	57

The total sum of patients in Table 2 is 197. This is due to the fact that in 5 cases both a residual depression and a condylar widening were found.

Table 3. Relationship between functional end result and osteoarthritis.

	Functional end result					
	Acceptable (Excellent+good)		Unacceptable (Fair+poor)		Total	
	No. cases	Percent	No. cases	Percent	No. cases	Percent
Osteoarthritis	23	14	17	62	40	21
No osteoarthritis	144	86	8	38	152	79
Entire series	167	100	25	100	192	100

Correlation to Residual Deformity of the Joint Surface (Table 2)

Comparison was made between, on the one hand, cases with residual maximum depression of the tibial table exceeding 5 mm and cases with a condylar widening exceeding 5 mm with, on the other hand, those cases in which the fracture either was undisplaced from the start or where treatment had succeeded in an anatomical restoration. Condylar widening seems to be a more significant factor in relation to posttraumatic arthritis than is residual depression. This difference, however, according to a rather strict rule of rejection used in this report, is not fully statistically significant ($X^2 = 8.63$. $0.01 < p. < 0.025$).

Correlation to the Functional End Results (Table 3)

Functional end results were graded according to a numerical system developed by the author (Rasmussen 1971). This system considered

the features: *Pain, walking capacity, range of motion and stability.* Osteoarthritis was four times more common among patients with a fair and poor functional end result. The frequency of arthritis among poor cases was 89 per cent (8/9), among fair cases 53 per cent (9/17).

General Posttraumatic Course

Of the 40 patients with osteoarthritis 10 per cent (4/40) stated that a free interval without symtoms preceded the development of pain and malfunction in the injured knee joint. The remaining 90 per cent (36/40) had experienced trouble in the knee during the entire follow-up period.

Table 4. 40 cases of osteoarthritis following tibial condylar fracture. Relationship between fracture type and localisation of osteoarthritis.

	Localisation of osteoarthritis			Total
	Lateral compartments	Medial compartment	Both compartments	
Lateral	7	5	9	21
Medial	2	2	1	5
Bicondylar	1	8	5	14
Total	10	15	15	40

Localisation of Osteoarthritic Changes (Table 4)

Whether the fracture was lateral, medial or bicondylar, destruction of the cartilage covered tibial joint surface generally was localised to the lateral compartment, where the entry of the fracture is to be found. In spite of this, osteoarthritic changes appeared with almost the same frequency in the lateral and medial joint compartment with 10 in the lateral, 15 in the medial and 15 in both.

DISCUSSION

Hohl & Luck (1956) observed a correlation between osteoarthritis and residual valgus angulation, and Apley (1956) mentioned that varus would lead to persistent pain. In a symposium on osteoarthritis of the knee, Maquet et al. (1967), in a biomechanical calculation, demonstrated that varus angulation of the knee increased the compressive

forces acting across the medial joint compartment while valgus seems to decrease them. In cases of primary osteoarthritis, varus angulation is met with much more often than valgus (Glimet 1963, Ahlbäck 1968, Bauer 1969).

That the roentgenological diagnostic criteria used in this investigation are clinically relevant is indicated by the correlation between osteoarthritis and clinical failures. This gains further support from the observation that 24 of the 40 patients with osteoarthritis suffered from incapacitating pain after weight-bearing. The age distribution was the same in the total series and the osteoarthritis series.

The results of this analysis support the view that biomechanical factors play a major role in the development of osteoarthritis after tibial condylar fractures. The most important initiating factor seems to be angular deformity, particularly varus angulation. The question of instability as a provoking factor is more controversial because it is impossible to know for certain whether the instability was primary or secondary to the degenerative changes. Instability appeared, however, with the same incidence in moderate and severe arthritis. One would expect a higher incidence in the latter group if it was secondary.

Patients with secondary arthritis rarely experienced a free interval without symtoms before pain and malfunction appeared.

The surface of the medial plateau was ruptured only in some cases of bicondylar fractures. Usually the plateau was fractured through the area just lateral to the intercondylar emminence. Nevertheless, in more than one third of the cases the degenerative changes were located solely to the medial compartment. In some cases I found in the lateral compartment pronounced deformation and irregularity as a result of a healed fracture, but without changes typical of arthritis, whereas this was present in severe degree in the medial joint compartment, which from the start was not at all affected directly by the injury. This latter observation indicates that the localised disruption of the cartilaginous joint surface is of less importance to the development of osteoarthritis than are the other factors under discussion: angular deformity, residual instability and condylar widening.

SUMMARY AND CONCLUSION

Osteoarthritis diagnosed according to well-defined roentgenological criteria appeared in 21 per cent of 192 tibial condylar fractures. The incidence of osteoarthritis in the opposite uninjured knee joint was

2 per cent. The appearance of posttraumatic osteoarthritis was closely correlated to: (1) type of fracture, with the highest incidence in the bicondylar group; (2) angular deformity, particularly varus; (3) residual lateral instability of the extended knee joint; (4) persistent condylar widening; (5) a functionally unacceptable end result.

The appearance of osteoarthritis was not correlated to: (1) the age of the patient; (2) persistent localised depression of the joint surface.

It is concluded that biomechanical disorder plays the major role in the development of osteoarthritis after tibial condylar fractures.

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