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MACINTOSH ARTHROPLASTY IN RHEUMATOID ARTHRITIS

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Knee joints, damaged by injury or various forms of destructive arthritis have been treated by arthroplasty for more than 100 years, but before 1950 the results were highly unpredictable with an overall incidence of success of about 43 per cent (Young 1963). In 1950 McKeever (McKeever 1960) and Townley (Townley 1964) independently suggested replacement of the tibial plateaux by vitallium plates. In 1954 MacIntosh introduced the prosthesis which is the subject of this paper. Although many years have elapsed since the introduction of these hemi-arthroplasty designs, the literature contains few detailed accounts of the results which can be expected following MacIntosh arthroplasty for rheumatoid arthritis in the hands of the "average" surgeon, as assessed by a doctor uninvolved in the patients' clinical care. The purpose of this paper is to provide such an account on another 69 knees.

MATERIAL AND METHODS

Between 1965 and 1970 the MacIntosh prosthesis was used for the treatment of rheumatoid arthritis in 69 knees in 55 patients at The London Hospital, England. At the time of follow-up 2 patients (2 knees) had died and one patient (1 knee) could not be traced. Thus 66 knees (95 per cent of those operated upon) were available for study. The time elapsed between operation and follow-up varied from 0.5 to 5.5 years (mean 2.8 years). Forty-seven patients (61 knees) were females and 8 (8 knees) males (87/13 per cent). The age of the patients at the time of operation varied from 17 to 79 years with a mean age of 55 years.

All patients suffered from definite rheumatoid arthritis (Ropes et al. 1959) and in all patients this was progressive and erosive. As shown in Table 1 the duration of the disease was from 3 to 32 years, and in the affected knee from one to 18 years. In 38 patients the latex test for rheumatoid factor was positive when performed by a modification of the method of Singer & Plotz (1956). Eighteen of the patients had subcutaneous rheumatoid nodules. Twenty-two were receiving corticosteroid treatment at the time of operation.

Table 1. Duration of the disease at the time of operation.

Duration of the disease at the time of operation	In the knee (No. of knees)	In the patient (No. of knees)
1–5 years	20	8
5–10 years	19	12
>10 years	27	46

Pre-operatively all patients suffered from pain and impaired functional capacity. In all knees there was limitation of movement, often associated with deformity and instability. Thirty-three patients suffered from disabling pain in other joints impairing their total functional capacity.

Radiographs showed grade IV rheumatoid changes in 64 knees and grade III changes in 2 knees (Kellgren et al. 1963). Secondary degenerative changes were often present as well.

The operation was performed as described by MacIntosh (1967). The tibial insertion of the patellar tendon was partially or totally detached in about a third of the operations. In 6 knees a patellectomy was performed, in 5 patellectomy had been performed earlier. The anterior part of the synovium was excised in 41 knees. The femoral condyles were re-shaped only if there were marked irregularities on their surfaces. In 59 knees a prosthesis was used both medially and laterally, in one medially, and in 9 laterally. In 2 knees the prosthesis was fixed with bone cement. Suction drainage was used routinely. Sixteen surgeons, Consultants and their Senior Registrars and Registrars, performed the operations described in this study.

The postoperative treatment involved bed rest for about 5 days with a light compression bandage and a plaster backslab. During this period isometric quadriceps exercises were encouraged. If wound healing was satisfactory on the 5th day, flexion exercises and partial weightbearing were allowed, emphasizing movement rather than weightbearing. If in the 3rd week flexion was less than 90 degrees,

Table 2. Criteria for grading the results.

Good	Pain		Alleviated - partially or completely
	Flexion		>70°
	Deformity	Flexion	<10°
		Valgus/Varus	<10°
Fair	One of the following:		
	Pain		Unchanged
	Flexion		<70°
	Deformity	Flexion	>10°
		Valgus/Varus	>10°
Poor	All other cases		

manipulation under general anaesthesia was performed. In uncomplicated cases the patient left the hospital after 3–4 weeks, but continued physiotherapy for 3–4 months.

The patients reviewed were asked direct questions regarding pain and functional capacity. The knees were individually examined recording the range of motion, stability and deformity. Radiographs were taken in the antero-posterior position in extension and in the lateral position with the knee in extension and in flexion as close to 90 degrees as possible. The sedimentation rate and the latex fixation test were recorded.

Because of the variations in the basic disease process and the involvement of other joints, assessment of these patients is difficult (Weinfeld 1969). In patients with severe disease, changes between the pre-operative and post-operative states give a more realistic assessment and this method has been used in this study. In addition an assessment table was developed grading the results, irrespective of the pre-operative state, as "good", "fair" and "poor" (Table 2). Thus relative and absolute results are both reported. The patients' own assessment and willingness to repeat the operation were also recorded.

Twenty-four (28 knees) had previously been reviewed in 1968 and in 1970 (Jessop & Moore 1972). Thus the present follow-up provided an opportunity for an exact assessment of the progress of these patients over the years 1968 to 1971.

Neither of the doctors who reviewed the patients in this study were involved in their clinical care.

RESULTS

The overall results in the 66 knees available for follow-up are set out in Table 3. There was broad agreement between the doctors' assessment and the patients' assessment although the patients were asked only if they regarded the results as "good" or "poor". Patients with good results stated that they would be prepared to have the operation again; patients with poor results stated that they would not. Overall, a good result was obtained in about 45 per cent of knees.

Twelve knees had had an arthrodesis or total knee replacement at the time of follow-up. These knees are included in Table 3 but are not included in Tables 4 to 9. Thus Tables 4 to 9 give the results of the

Table 3. The overall results in 66 knees.

	Doctors' assessment		Patients' assessment	
	No. of knees	Percentages of knees	No. of knees	Percentages of knees
Good	25	38	35	53
Fair	15	23	–	–
Poor	26	39	31	47

Table 4. Assessment of pain.

	No. of knees
Completely alleviated	22
Partially alleviated	21
Unchanged	10
Increased	1
Total	54

	Preoperative pain No. of knees	Postoperative pain No. of knees
No pain	0	22
Occasional pain	3	14
Pain on walking	21	9
Pain at rest	30	9
Total	54	54

54 knees in which a MacIntosh arthroplasty had functioned for 0.5 to 5.5 years.

As shown in Table 4 pain was completely relieved in 41 per cent and improved in a further 41 per cent.

Improvement in the overall functional capacity, shown in Table 5, was very limited, occurring mainly in patients with relatively good pre-operative function. Walking ability did not improve, nor did the need for walking aids. The ability to manage stairs improved but the ability to put on shoes and stockings and to rise from a sitting position in a chair deteriorated. Thirty-three patients had serious limitations from other joints impairing their functional capacity but the results in these patients were not worse than in the others.

The range of movement is recorded in Table 6. In 21 knees (38 per cent) the range of movement improved and in 14 it deteriorated. Loss of flexion was more common in the group classified as "poor" than in the other two groups, but inadequate pain relief rather than stiffness was the factor usually responsible for a "poor" grading.

In 11 knees there was a post-operative extensor lag of between 20 and 60 degrees. None of these patients was classified as "good".

In 42 knees there was a pre-operative flexion deformity of between 5 and 45 degrees. Only in 16 of these knees was the deformity fully

Table 5. Pre- and post-operative functional capacity.

	No. of knees	
	Pre-operative	Post-operative
Ability to walk:		
Over one mile	2	5
Outdoors up to one mile	28	28
Indoors	22	19
Unable	2	2
Use of walking aids:		
None	17	15
1 stick	20	17
2 sticks	12	14
Crutches	3	6
Wheelchair	2	2
Ability to climb stairs:		
Able	6	15
Able with difficulty	34	18
Unable	14	21
Ability to reach feet:		
Able	31	32
Able with difficulty	17	8
Unable	6	14
Ability to rise from a chair with "push-off":		
Able	36	33
Able with difficulty	15	13
Unable	3	8
Overall:		
Able to do anything	0	8
Some limitations, but independent	11	6
Some degree of dependence	28	25
Completely dependent	15	15

corrected (Table 6) and in none of the knees with a deformity exceeding 25 degrees (8 knees) was full correction achieved. In these 8 knees the results were "poor".

Valgus deformity was a common pre-operative finding (32 knees), but varus deformity was observed in one knee only. Correction was achieved in 26 of the knees with a valgus deformity and in the one knee with a varus deformity (Table 7). All knees with a pre-operative valgus deformity exceeding 20 degrees (6 knees) had "poor" results.

Antero-posterior and lateral instability was present in 24 and 33 knees, respectively. Twenty-one knees displayed both forms of in-

Table 6. Range of movement.

Flexion	No. of knees
Improved	21
Unchanged	19
Deteriorated	14
Extension	No. of knees
Full extension maintained	8
Full extension gained	16
Persistent flexion deformity	26
Developed flexion deformity	4
Total range of movement	No. of knees
Improved	21
Unchanged	19
Deteriorated	14

stability. Stability was improved in about 40 per cent of knees remaining as MacIntosh arthroplasties (Table 8). There was no relation between pre-operative instability and the end result.

The operation did not cause any generalized flare-up nor remission of the basic disease. Neither the sedimentation rate nor the latex tests were affected. The number of patients on steroid treatment was smaller at review (18) than at the time of operation (22). These results are similar to the findings following simple synovectomy of the knee joint at the London Hospital (Mason 1969).

Radiologically, two sequels to the operation appeared to affect the outcome: collapse of the femoral condyles and collapse of the bone supporting the prostheses. Collapse of the femoral condyles, presumably due to the bone of the condyles being crushed against the metal plates on the tibia, was associated with a "poor" result. Figure 1

Table 7. Correction of varus and valgus deformities.

	No. of knees
Corrected varus deformity	1
Persistent varus deformity	0
Developed varus deformity	3
Corrected valgus deformity	26
Persistent valgus deformity	6
Developed valgus deformity	2

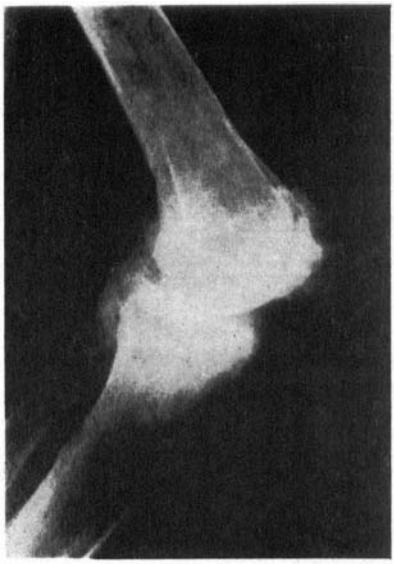

Figure 1 a.

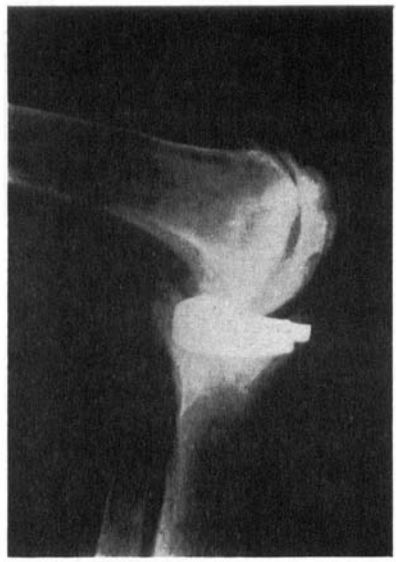

Figure 1 b.

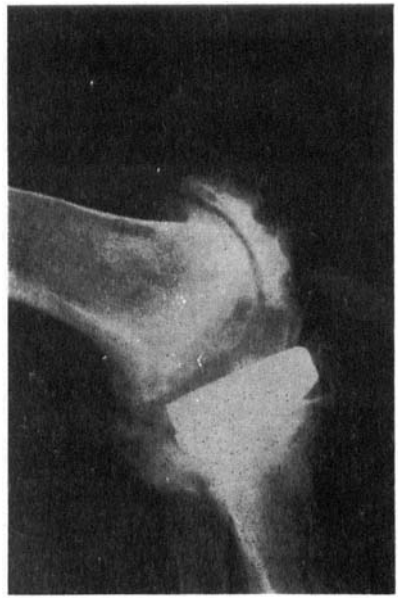

Figure 1 c.

Figure 1 a. Pre-operative radiograph. Lateral view of the knee joint in flexion affected by rheumatoid arthritis for 11 years. Contour of the femoral condyles appears well preserved.
Figure 1 b. Post-operative radiograph. Lateral view of the same knee joint 2 years after insertion of MacIntosh prostheses, showing well-marked flattening of the femoral condyle.
Figure 1 c. Gross destruction of the femoral condyle in the same knee 3 years after arthroplasty.

Table 8. Instability.

	Antero-posterior instability No. of knees	Lateral instability No. of knees
Improved	19	22
Unchanged	28	26
Deteriorated	7	6
	54	54

demonstrates this in its most extreme form and in 7 other radiographs collapse was noted to a much milder degree. Contact between the femur and the inter-condylar eminence of the tibia as a result of collapse of the bone supporting the prosthesis was also associated with a "poor" result.

Particular note was taken of the influence of the operative technique on the end result. In 55 knees in which two tibial prostheses were inserted 22 (40 per cent) were "good" results as compared to 3 (27 per cent) out of 11 knees in which one prosthesis had been inserted. Patellectomy performed at the time of arthroplasty (6 knees) was associated with only one "good" result (17 per cent), whilst patellectomy performed at an earlier operation (5 knees) did not influence the end result. Synovectomy performed at the time of operation was associated with a "good" result in 49 per cent of knees so treated, as against an incidence of 20 per cent of "good" results when the synovium was left in place.

Manipulation under anaesthesia was performed in 34 knees. The final range of movement was better in knees manipulated than in those that were not.

Table 9. The results in 28 knees assessed in 1968, 1970 and 1971.

	1968	1970	1971
		No. of knees	
Good	13	12	11
Fair	8	4	4
Poor	7	12	13
Mean duration of follow-up (months)	16	36	48

Table 10. Secondary operations required following arthroplasty.

Procedure			No. of knees
Arthrodesis			8
Total replacement:	Shiers	1	
	Freeman-Swanson	3	
	Total		4
Internal fixation fractured femur			1
Exploration:	Infection	2	
	Avulsed patellar tendon	3	
	Loose prosthesis	1	
	Total		6
			19 (28 %)

Although the number of operations performed by some surgeons in this study was too small to permit satisfactory comparison, there did not appear to be any marked differences between the results obtained by any of these 16 surgeons.

The results in the patients reviewed in 1968 and 1970 (Jessop & Moore 1972) and 1971 are summarized in Table 9. The results deteriorated over the years mainly from the group recorded as "fair".

Secondary operations were required in 28 per cent of knees. (Table 10).

Superficial infections occurred in 11 knees and usually cleared up with antibiotics. However, in 2 knees the joint was eventually involved and removal of the prosthesis and arthrodesis was required. Three knees developed deep infections *per primum*. Two healed with systematic antibiotics whilst one had to be arthrodesed. Staphylococcus aureus was the usual organism cultured.

Two supracondylar fractures occurred during manipulation. One knee required internal fixation and both had to be immobilized for an unusually long period of time. Both gave "poor" results.

Avulsion of the patellar tendon occurred in 4 knees in which the tendon had been partially or totally detached at operation.

In one knee an unsuitably high prosthesis had been used causing pain and stiffness. After revision the result was "fair".

In one knee in which the prosthesis had been cemented in place, loosening occurred and revision had to be performed. The result at follow-up was "fair".

DISCUSSION

We have found 14 publications describing the results of the MacIntosh arthroplasty in rheumatoid arthritis. Of these publications, many are synopses of verbal communications and are too brief to form a basis for evaluation (Murray 1967, Dewar 1968, Kates et al. 1969, MacIntosh 1958, 1966 and 1967, McCollum et al. 1970, Lowe et al. 1971, Nelson & Evarts 1971). Henderson & Petersen (1969) described their results in sufficient detail to permit some cross-comparison but their study was based on only 15 patients. Potter (1969) and Potter et al. (1972) reported the results obtained by several surgeons using the McKeever prosthesis in 63, and the MacIntosh prosthesis in 29 rheumatoid knees. Fifty-six per cent of knees finally obtained a "good" or "excellent" result. MacIntosh & Hunter (1972) reported 68.5 per cent good results in 89 rheumatoid knees. Since MacIntosh was one of the originators of this operation, this result probably reflects the best that can be obtained with the procedure rather than the result that can be obtained in the hands of the "average" surgeon. Finally Kay & Martins (1972) reported on 44 knees with 43 per cent good and 22 per cent satisfactory results and with relief of pain in 85 per cent.

There are several reasons why our results may be less satisfactory than those in other reports. These include the selection of patients, the operative technique, the duration of follow-up and the methods of assessment.

Ideally the results of any operation should be assessed, like those of a drug, by a double blind trial. Since this is impossible, it is difficult to eliminate either a placebo response or observer bias from the assessment of a surgical procedure. One reason for believing that the long term results reported in this study are free from observer bias is that the doctors carrying out the final assessment were not involved in the clinical care of the patients concerned. We further consider that these results, based as they are upon operations carried out by 16 different surgeons, represent the results obtainable by the "average" surgeon.

The only marked post-operative symptomatic improvement in this series was in pain: if knees which had to be converted to an arthrodesis or to total replacement are regarded as having given unsatisfactory pain relief, pain was partially or completely relieved in 65 per cent of knees. Unfortunately this pain relief can not certainly be ascribed to surgery since the alternative possibility that it represents a placebo response can not be excluded. In general it is recognised that the

rheumatic disorders are at least as susceptible to the placebo response as are patients with other diseases (Mason 1962). The persistence of pain relief in those who improved in this study—up to 5.5 years—is however uncharacteristic of the placebo response which is usually short-lived. Wolf (1959) has, however, described improvement in 80 per cent of patients at a 5-year follow-up after an inappropriate operation which he attributed to the "placebo personality" of the surgeons concerned. It may also be true that reinforcement (of the placebo effect) by repeated follow-up examination could be a factor accounting for our observations in this series. Such an effect, of frequent attention and repeated measurement, has been demonstrated by Currey (1965) in a rather similar situation when studying the effect of placebo injections into arthritic joints. The suspicion that pain relief in the present study may have been partly due to a placebo response is perhaps reinforced by our further finding that no functional improvement accompanied the relief of pain, since activities such as walking or climbing stairs may be less susceptible than pain to improvement by a placebo effect.

In the patients in this study the range of movement was not reliably increased. If the 12 knees which required a conversion to arthrodesis or total replacement are included, more knees lost movement than gained it: a finding which accords with the fact that the number of patients able to reach their feet was not increased by operation. It of course remains possible that had these patients not been operated upon, the progress of the disease would have reduced the range of movement still further.

Valgus and varus deformities were satisfactorily improved. Flexion deformities were less reliably improved. Although the correction of deformity is obviously a gain, it is of relatively little use if it is not accompanied by improvement in function.

The detailed follow-up carried out on 28 patients in 1968, 1970 and 1971 shows that the results tend to deteriorate with time. This deterioration was particularly noticeable in patients who initially obtain a "fair" result but also affected those initially graded as "good". It would appear that if a good result is to be obtained with this operation, it will be evident within the first post-operative year: improvement thereafter does not occur.

In attempts to improve the final results several previous authors have proposed contra-indications to this procedure. These are listed in Table 11. All authors have found that a flexion deformity in excess

Table 11. Proposed contraindications to the MacIntosh arthroplasty, and the effect of applying the contraindications to the present study.

	Nelson et al.	Henderson et al.	Potter et al.	Lowe et al.	Kay et al.	MacIntosh et al.	Andersson et al.
Flexion deformity	yes (30°)	yes (30°)	yes (30°)	yes (20°)	yes (20°)		yes (25°)
Severe destruction of tibial plateau, not compensatable	yes		yes	yes	yes	yes	yes
Severe osteoporosis	yes	yes	yes				yes
Valgus or varus deformity	yes (30°)		yes (30°)		yes (15°)		yes (20°)
Predominant femoral condylar involvement	yes			yes			
Double hemi-arthroplasties		yes					
Fatient chairbound		yes					
Large cysts extending into the joint			yes				
Poor quadriceps function			yes				
Immobile patella					yes		
Lateral shift of tibia			yes			yes	
Previous sepsis or ankylosis						yes	
Instability				yes			
Poor motivation						yes	
Restricted movement primary complaint				yes			
60° arc of movement or less					yes		
Number of knees in this study excluded:	15	58	15	37	38	2	19
Results in	%	%	%	%	%	%	%
the remaining knees: Good	23 45	2 25	22 43	12 41	11 39	25 40	25 53
Fair	10 20	3 37.5	11 22	7 24	3 11	15 23	8 17
Poor	18 35	3 37.5	18 35	10 35	14 50	24 37	14 30

of 20 to 30 degrees represents a contra-indication and we would concur with this. We also found, as did Nelson & Evarts (1971), Potter (1969, 1972) and Kay & Martins (1972) that a valgus or varus deformity of about 20 to 30 degrees represented a contra-indication. Primary involvement of the femoral condyles has been suggested as a contra-indication by Nelson & Evarts (1971), Kay & Martins (1972), and by Lowe et al. (1971). In Table 11 we show the effect of applying the contra-indications listed by previous authors to the 66 knees reported in this study. It will be seen that when some contra-indications are applied, particularly those of Henderson & Peterson (1969), Lowe et al. (1971) and Kay & Martins (1972), very few knees remain available for study. This suggests that the patients operated upon in this study were on the whole more severely affected than those in some previous series. When all the knees in this study to whom the various contra-indications listed in Table 11 apply are eliminated, only 2 knees remain: in one the result was good, in the other poor. More realistically, some improvement is obtained if knees displaying a flexion deformity in excess of 25 degrees, a valgus or varus deformity in excess of 20 degrees, severe destruction of the tibial plateaux not compensatable by the insertion of a prosthesis, and severe osteoporosis are excluded. If these criteria are applied to our study 19 knees (30 per cent of the present series) would not have been operated upon and of the remaining knees the results would have been "good" in 53 per cent.

Our findings suggest that the best results can be obtained if the insertion of the prosthesis is not combined with patellectomy but is combined with synovectomy and is followed by a manipulation under anaesthesia. Lowe et al. (1971) found that the results could be further improved by cementing the prosthesis in place.

SUMMARY

Sixty-six knees in 53 patients have been assessed 0.5 to 5.5 years after MacIntosh arthroplasty for rheumatoid arthritis.

At the time of follow-up 12 knees (18 per cent) had been converted to an arthrodesis or total replacement.

Pain was completely or partially relieved in 65 per cent of knees.

The range of movement was not reliably increased.

Valgus and varus deformities were satisfactorily improved. Flexion deformities were less reliably improved. Deformities of any kind in excess of 25 degrees could not be fully corrected.

In an attempt to make a total assessment, 38 per cent were graded as "good", 23 per cent as "fair" and 39 per cent as "poor".

If the selection of patients in this study was adequate we must conclude that in the hands of the "average" surgeon using the technique here described the MacIntosh arthroplasty does not appear greatly to benefit the knee in rheumatoid arthritis.

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