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Manipulation of total knee replacements

IS THE FLEXION GAINED RETAINED?

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As part of a prospective study of 476 total knee replacements (TKR), we evaluated the use of manipulation under anaesthesia in 47 knees. Manipulation was considered when intensive physiotherapy failed to increase flexion to more than 80°. The mean time from arthroplasty to manipulation was 11.3 weeks (median 9, range 2 to 41). The mean active flexion before manipulation was 62° (35 to 80). One year later the mean gain was 33° (Wilcoxon signed-rank test, range -5 to 70, 95% CI 28.5 to 38.5). Definite sustained gains in flexion were achieved even when manipulation was performed four or more months after arthroplasty (paired *t*-test, $p < 0.01$, CI 8.4 to 31.4).

A further 21 patients who met our criteria for manipulation declined the procedure. Despite continued physiotherapy, there was no significant increase in flexion in their knees. Six weeks to one year after TKR, the mean change was 3.1° (paired *t*-test, $p = 0.23$, CI -8.1 to +2).

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While the primary aims of total knee arthroplasty are relief of pain and restoration of mobility, an adequate range of movement (ROM) is also desirable. Laubenthal, Smidt and Kettelkamp[1] assessed the amount of flexion necessary for everyday activities and found that the mean flexion required to climb stairs, to sit, and to tie a shoelace was 83°, 93° and 106°, respectively. The ROM attained after total knee replacement (TKR) depends not only on such factors as prosthetic design and soft-tissue balance, but also on patient morphology, the preoperative ROM and motivation.[2-4] Some patients may be satisfied with less flexion as long as they have relief from pain.

The long-term benefits of manipulation under anaesthesia (MUA) after TKR have been questioned.[5] The known complications of manipulation, including supracondylar fracture, avulsion of the patellar tendon, myositis ossificans and wound breakdown, may further compromise poor results. These occur, however, in fewer than 3% of patients.[6] Our aim was to evaluate the use of MUA in patients whose maximum flexion was less than 80° despite intensive physiotherapy.

Patients and Methods

In 1987, we began a prospective, randomised study comparing 476 cemented and uncemented posterior-cruciate-retaining TKRs (PFC; Johnson & Johnson, Bracknell, UK) which had been performed or directly supervised by the senior author (PJG). None of the patellae had been resurfaced but their osteophytes had been excised. The deep and superficial layers had been closed with interrupted sutures. Under the supervision of a physiotherapist, knee flexion began when the wound drains were removed 48 hours after surgery. Continuous passive motion (CPM) was not used except after manipulation. A goniometer was used to measure results.

Manipulation was considered in patients in whom maximum flexion remained less than 80° despite intensive physiotherapy. This was performed on 47 (group 1) out of 68 knees. The remaining 21 patients (group 2) declined manipulation but continued with physiotherapy.

Group 1 (manipulation group). There were 18 men and 24 women with a mean age of 67 years (51 to 88). Five patients had bilateral replacements, two of them simultaneously, and required manipulation of both knees. In all but one, who had rheumatoid arthritis (RA), the underlying pathology was osteoarthritis (OA). High tibial osteotomy had been performed on two knees; these were the only previous surgical procedures in this group. There were varus deformities in 38 knees. In 19 cases neither the femoral nor the tibial component had been cemented. Before arthroplasty, the mean active flexion was 102° (60

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Table I. Flexion (degrees) in patients in group 1 who had MUA

	Before arthroplasty	Before MUA	At MUA	Max active after MUA	1 year after MUA	2 years after MUA
Mean	102	62.0	96.0	92.5	95.6	97.4
SEM	2.7	1.7	1.1	1.1	2.0	2.1
Range	60 to 135	35 to 80	75 to 120	77 to 110	70 to 130	70 to 137

to 135). The mean time from implantation to manipulation was 11.3 weeks (median 9, range 2 to 41). Before manipulation, the mean flexion was 62° (median 65, range 35 to 80).

Group 2 (patients who declined manipulation). There were nine men and 12 women with a mean age of 67 years (46 to 81). The primary pathology was OA in 19 patients and RA in two. None had previous knee surgery. Before arthroplasty, there were varus deformities in 20 knees. In five, the implants were uncemented. The mean active flexion before arthroplasty was 84.7° (60 to 110). The physiotherapist continued to treat these patients.

Manipulation technique. Before manipulation, the ROM of the knee and its resistance to further flexion were assessed under general anaesthesia. The surgeon supported the lower leg proximally and distally and an assistant supported the thigh. A steady progressive force was applied to the proximal tibia until the adhesions gave way. After this, all the knees could be flexed, under anaesthesia, to at least 90°. For 24 hours after MUA a CPM machine was used. Patients were discharged when they had made satisfactory progress.

Statistical analysis. The Wilcoxon signed-rank test was used to determine whether the recorded changes in flexion were significant. We used a paired *t*-test to compare changes in flexion within each group and a two-sample *t*-test to compare the groups. The 95% confidence intervals (CI) are given.

Results

Group 1. The mean improvement in passive flexion at MUA was 34° (10 to 65, CI 30 to 37.5). In the week after MUA, active flexion equalled or exceeded this in 31 of the 47 knees. By the following year, 33 patients had gained flexion, ten had lost flexion and four showed no change. The estimated median change for this period was 4° (-26 to +37, CI 0 to 7.0). One year after MUA the mean increase in active flexion was 33° ($p < 0.01$; CI 28.5 to 38.7) and the mean active flexion was 95.6° (median 90, range 70 to 130). Three knees flexed only 10° more than they did before MUA, and one showed no gain. There was no appreciable change in flexion in the second year after MUA. Ten patients were unable to flex to 90°. Four of these had a late MUA (at 16, 17, 20 and 25 weeks). In three of the ten, flexion before TKR had been less than 80°. Table I and Figure 1 show the results.

In eight patients MUA was performed more than 16 weeks (17 to 41) after arthroplasty. Flexion improved in seven who had a mean gain of 24° in active flexion (0 to 33; CI 13.5 to 33.0). One year later, five of the eight knees were able to flex beyond 90° (mean 87, range 70 to 105). Despite the delay before MUA, the gain in flexion at one year was significant ($p < 0.01$; CI 8.4 to 31.4).

Whether the components had been cemented or not made no difference to the gain in flexion ($p = 0.35$; CI -4 to 11), or in retention of the increase gained ($p = 0.84$, CI -8.9 to 11).

There were no complications as a result of the manipulation.

Group 2. The mean active knee flexion was 73.6° (50 to 80) six weeks after TKR. There was no significant change in flexion ($p = 0.23$; CI -8.1 to 2.0) between six weeks and one year when the mean active flexion was 76.7° (62 to 90). Between one and two years, knee flexion did not change appreciably ($p = 0.37$; CI -7.2 to 2.7). As shown in Table II the mean at two years was 79° (55 to 90). At that

Table II. Flexion (degrees) in patients in group 2 who did not have MUA

		After arthroplasty		
	Before arthroplasty	6 weeks	1 year	2 years
Mean	84.7	73.6	76.7	79.0
SEM	3.5	1.9	1.6	1.8
Range	60 to 110	50 to 80	62 to 90	55 to 90

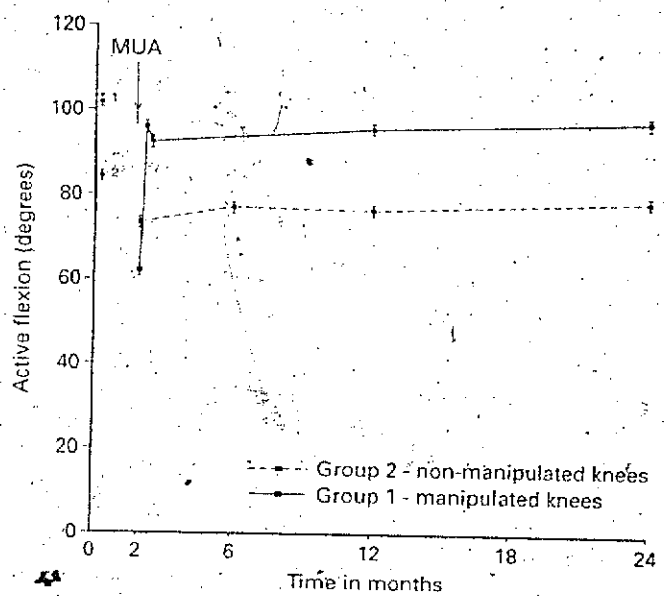

Fig. 1

Maximum active knee flexion (degrees) related to the time after TKR. The error bars show the SEM.

time 14 knees flexed less than 80° and only four flexed more than 90°. Thirteen patients in this group had less flexion one year after TKR than they had before (mean loss 21°; range 7 to 37).

Comparison of groups 1 and 2. The group of patients who declined MUA had significantly worse flexion before TKR ($p < 0.01$; CI -26 to -8.1). At the time at which MUA was considered, however, flexion was significantly worse in the group of patients who consented ($p < 0.01$; CI -16.5 to -6.5). At one and two years there was significantly greater flexion in the manipulated than in the non-manipulated group (at one year $p < 0.01$, CI 13.7 to 24.0; at two years $p < 0.01$, CI 12.1 to 23.5). Figure 1 shows the results for both groups.

Discussion

There are few reports about manipulation after TKR. In a series of 343 TKRs, Fox and Poss[5] reported the results of manipulation of 23% of predominantly (70%) rheumatoid patients with a mean age of 63 years. Manipulation was performed two weeks after surgery if the patient had less than 90° of flexion. They found that manipulation was more likely to be necessary if patients were female, osteoarthritic or over 70 years of age. At MUA, they achieved a mean gain in flexion of 37°, but one week later only 17° of this remained. After one year, the mean gain in flexion was only 13°. A retrospective study of 17 patients who had bilateral TKRs but MUA in only one knee led them to conclude that the procedure did not increase the ultimate range of flexion after TKR.

Since our patients were not selected at random, group 2 cannot be considered to be a control group. Arthroplasty resulted in a reduction of flexion in these patients. Having had poor flexion before surgery, they may simply have been willing to accept a restricted ROM in order to gain freedom from pain. Alternatively, their poor results may reflect their levels of motivation. Without carrying out a prospective randomised trial, we cannot be sure that improvement would not have occurred without manipulation.

Several studies have shown that the use of a CPM[1] machine immediately after arthroplasty does not affect the ultimate ROM but does increase the rate at which flexion is regained.[7-9] This accelerated return of flexion may reduce the need for manipulation.[7,10] To minimise the risk of hypoxia of the wound edge and subsequent infection, Johnson[11] and Goletz and Henry[12] recommend limiting CPM to less than 40° in the early postoperative period.

Our primary aim at MUA was to overcome intra-articular adhesions. We stopped manipulating as soon as we felt that we had achieved this. We believe that manipulation beyond this point could increase the risk of the complications which have given MUA a poor reputation.

Daluga et al[13] found no difference in the results of MUA carried out up to 21 days after TKR, or at between 22 and 90 days. Because definite and sustained gains in flexion can be achieved even when MUA is performed several months after TKR, there is no reason to manipulate when the wound is at its weakest.

We found that one year after MUA flexion in 15 of 47 knees had increased beyond that achieved then. After TKR, MUA can lead to sustained increases in flexion in knees that are no longer improving, despite physiotherapy. We believe, however, that the improvements in flexion are unlikely to be sustained unless patients have access to adequate physiotherapy afterwards.

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References

1. **Laubenthal KN, Smidt GL, Kettelkamp DB.** A quantitative analysis of knee motion during activities of daily living. *Phys Ther* 1972;52: 34-43.
2. **Ritter MA, Stringer EA.** Predictive range of motion after total knee replacement. *Clin Orthop* 1979;143:115-9.
3. **Schurman DJ, Parker JN, Ornstein D.** Total condylar knee replacement: a study of factors influencing range of motion as late as two years after arthroplasty. *J Bone Joint Surg [Am]* 1985;67-A:1006-14.
4. **Parsley BS, Engh GA, Dwyer KA.** Preoperative flexion: does it influence postoperative flexion after posterior-cruciate-retaining total knee arthroplasty? *Clin Orthop* 1992;275:204-10.
5. **Fox JL, Poss R.** The role of manipulation following total knee replacement. *J Bone Joint Surg [Am]* 1981;63-A:357-62.
6. **Insall J, Scott WN, Ranawat CS.** The total condylar knee prosthesis: a report of two hundred and twenty cases. *J Bone Joint Surg [Am]* 1979;61-A:173-80.
7. **Romness DW, Rand JA.** The role of continuous passive motion following total knee replacement. *Clin Orthop* 1988;266:34-7.
8. **Colwell CW Jr, Morris BA.** The influence of continuous passive motion on the results of total knee arthroplasty. *Clin Orthop* 1992; 276:225-8.
9. **Pope RO, Corcoran S, McCaul K, Howie DW.** Continuous passive motion after primary total knee arthroplasty: does it offer any benefits? *J Bone Joint Surg [Br]* 1997;79-B:914-7.
10. **Coutts RD, Sharp DN, Borden LS, et al.** The effect of continuous passive motion on total knee rehabilitation. *Orthop Trans* 1983;7: 535-6.
11. **Johnson DP.** The effect of continuous passive motion on wound-healing and joint mobility after knee arthroplasty. *J Bone Joint Surg [Am]* 1990;72-A:421-6.
12. **Goletz TH, Henry JH.** Continuous passive motion after total knee arthroplasty. *South Med J* 1986;79:1116-20.
13. **Daluga D, Lombardi AV Jr, Mallory TH, Vaughan BK.** Knee manipulation following total knee arthroplasty. *J Arthroplasty* 1991; 6:119-28.