Fixation of the tibial component of total knee arthroplasty after high tibial osteotomy

A MATCHED RADIOSTEREOMETRIC STUDY

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To assess migration of the tibial component we used roentgen stereophotogrammetric analysis in 40 patients who had had a total knee arthroplasty after failure of a closing wedge osteotomy and compared them with 40 matched patients after primary total knee arthroplasty.

We found no difference in migration over time or in the tendency for continuous migration between the two groups. There were no differences in alignment or position of the knee prosthesis or in the clinical outcome.

Our findings show that revision of a failed high tibial osteotomy to a total knee arthroplasty is effective.

J Bone Joint Surg [Br] 1998;80-B:295-7.

Received 14 July 1997; Accepted 1 October 1997

There is still dispute as to whether a previous high tibial osteotomy may compromise the success of total replacement arthroplasty of the knee. The potential success of such a procedure is a factor in any decision to perform an osteotomy in the first place. Many orthopaedic surgeons find it technically more demanding to perform an arthroplasty after a previous closed-wedge osteotomy¹ because the knee may well be tight, the patellar ligament short,² access to the lateral compartment difficult and rotation of the tibial plateau confusing. A V-Y quadriceps plasty is often needed. Some surgeons have reported that the results of total knee arthroplasty (TKA) after failed proximal tibial osteotomy are not equal to those after a primary procedure,³⁻⁶ while others report results which are comparable.^{7,8}

We have compared the fixation of the tibial component

after a previous high tibial osteotomy with that following primary arthroplasty using roentgen stereophotogrammetric analysis (RSA).⁹

Patients and Methods

We obtained the radiographs of 40 patients who had had TKA after previous upper tibial osteotomy from the RSA data base at the Departments of Orthopaedics in Lund and Malmö, Sweden. These were matched with a similar number from patients who had received a primary arthroplasty, as regards the type of prosthesis, the time of follow-up, gender, age and weight.

There were equal numbers of cemented and uncemented prostheses of the same type in each group. Table I gives the different types.

There were 26 women and 14 men in the osteotomy group and 27 women and 13 men in the primary arthroplasty group. At the time of receiving the prosthesis patients in the osteotomy group had a mean age of 69 years (55 to 79), a mean weight of 82 kg (50 to 114) and a mean height of 164 cm (150 to 189). In the primary arthroplasty group the mean age was 70 years (60 to 79) at the time of operation, the mean weight was 80 kg (59 to 110) and the mean height 167 cm (152 to 190).

The mean interval between proximal tibial osteotomy and conversion to a prosthesis was ten years (2 to 22). Two patients were revised to a prosthesis after two years, one after three and one after four years. The remainder had a revision after more than six years. In the osteotomy group three patients had a second osteotomy before the replacement arthroplasty.

Clinical assessment was by the Hospital for Special

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0301-620X/98/28153 \$2.00

Table I. Types of prosthesis used

Prosthesis	Number
Total condylar knee	5
PCA primary prosthesis	14
Kinematic	2
PCA MK II bossed version	4
Duracon cruciform HA	1
Osteonics 7000	2
Insall-Burstein CCK II	1
PFC	9
PFC HA	2

Table II. Mean ($\pm$ SEM) proximal total point motion (MTPM) in the two groups

Year after operation	Number	Group	MTPM (mm)	p value
1	34	Osteotomy	1.1 $\pm$ 0.2	0.23
	38	Primary	0.8 $\pm$ 0.1	
2	24	Osteotomy	1.1 $\pm$ 0.3	0.68
	30	Primary	1.0 $\pm$ 0.1	
5	21	Osteotomy	2.3 $\pm$ 0.9	0.28
	20	Primary	1.3 $\pm$ 0.2	
10	5	Osteotomy	2.3 $\pm$ 0.9	0.05
	15	Primary	1.1 $\pm$ 0.2	

Surgery (HSS) rating scale^{10,11} which scores 30 points for pain, 22 for function, 18 for mobility and 10 each for muscle strength, flexion deformity and instability.

We performed conventional radiography to determine the position of the prosthesis in relation to the bone using the prosthesis-tibia (PT) and the prosthesis-tibia-side (PTS) angles. The mechanical axis (the hip-knee-ankle) was determined by the use of full leg-length radiographs. Related to the prosthetic surgery the preoperative HKA angle was 170° (156 to 195) for the osteotomy group and 173° (148 to 205) for the primary prosthetic group. For the osteotomy group 31 patients had a preoperative (before the prosthetic operation) HKA angle; 28 of these were under-corrected (HKA < 180°, n = 24) or excessively overcorrected (HKA > 190°, n = 4).

The operating time and details of problems encountered during operation were obtained from the case notes.

Roentgen stereophotogrammetric analysis. RSA was performed soon after operation and at 6 weeks, 6 months, and at 1, 2, 5 and 10 years.

All patients were prepared for RSA⁹ by inserting tantalum balls with a diameter of 0.8 mm during operation into the proximal tibia and the polyethylene of the tibial component. These provided distinct points of identification on future radiographs.

We analysed migration between the tibial component and the tibial bone over time. Movement was described as segment motion (translation or rotation of the geometric centre of the polyethylene insert) or as point motion (translation of single prosthetic markers). The maximum total point motion (MTPM), which is the total three-dimensional vector translation of the marker that moved most in any one position during the entire series, was used as a means of denoting the magnitude of the migration. The accuracy of the RSA system is 0.3° for single axis rotation and 0.2 mm for translation.¹²

The prostheses were classified as stable or migrating according to the migration between the follow-up at one year and at two years. A migration of less than 0.2 mm was classified as stable, and this was found in 24 patients who had had previous osteotomy and in 31 with a primary arthroplasty.¹³

The ANOVA and chi-squared tests were used for statistical evaluation.

Table III. Mean (range) HKA, PT and PTS angles after arthroplasty in both groups

	HKA	PT	PTS
Osteotomy	178 (167 to 194)	88 (82 to 98)	87 (80 to 95)
Primary	180 (170 to 191)	87 (82 to 92)	87 (77 to 95)

Table IV. Mean (range) HSS score, range of movement (degrees) and walking distance (m) in both groups after arthroplasty

	HSS	ROM	Walking distance
Osteotomy	85 (66 to 98)	104 (30 to 130)	1900 (50 to 10 000)
Primary	88 (76 to 99)	104 (25 to 130)	1400 (10 to 5000)

Results

There were no significant differences in the MTPM of both groups after one year. That for the osteotomy group was 1.1 $\pm$ 0.2 mm and for the primary prosthetic group 0.8 $\pm$ 0.1 mm (p = 0.23). No differences were noted at two and five years. After ten years there was a slight difference; the MTPM for the osteotomy group was 2.3 $\pm$ 0.9 mm as against 1.1 $\pm$ 0.2 mm for the primary prosthetic group (p = 0.054; Table II) but only five patients in the osteotomy group had been followed for ten years. There were no significant differences in segment translation or rotation between the two groups, or in the tendency for continuous migration. In the osteotomy group three of 21 and in the primary arthroplasty group seven of 24 were classified as having continuous migration between one and two years (p = 0.37).

The operating time in the osteotomy group was 147 $\pm$ 35 minutes compared with the 134 $\pm$ 37 minutes in the primary prosthetic group (p = 0.11). In 16 cases in the osteotomy group problems were recorded with access to the knee because of a tight knee or difficulty in everting the patella. This was encountered only once in the primary group.

There were no significant differences in alignment or position of the knee prosthesis (Table III) or in the clinical outcome (Table IV) between the two groups.

Four patients with a previous osteotomy later required revision of the knee prosthesis, one twice. One patient had a revision after fracture of the patella which caused loosening and malalignment and one because of wear of the polyethylene component. One patient in this group had a unicompartmental knee which was later revised to a TKA. The fourth had revision because of increasing pain. Of the patients with a primary arthroplasty one had revision because of problems with the patella.

Discussion

Total knee replacement in younger patients is fraught with potential long-term risk.¹⁴ High tibial osteotomy is an excellent alternative,^{15,16} but may compromise a subsequent TKA, should the osteotomy fail. To assess micro-motion, we used RSA, which has been shown to be sensitive in assessing fixation of the tibial component.¹³

We found no difference in the prosthetic fixation expressed as micromotion for the two groups. The migration over time as well as the prognostically continuous migration were the same for both groups, the former osteotomy group and the primary prosthetic group.

Even if there was a slightly higher migration in the group operated on after a previous osteotomy (NS) and even if in our series there were more later prosthetic revisions (NS) this does not condemn high tibial osteotomy as a treatment. The slightly inferior results of knee arthroplasty after osteotomy were statistically insignificant. The potential problems after primary TKA in the young patient suggest that, on balance, high tibial osteotomy should be the first choice in the long-term management of these patients. If they eventually require a replacement arthroplasty the presence of a previous osteotomy does not appear to influence the fixation or function of the prosthesis. Operation for an arthroplasty is more difficult after a previous osteotomy, and may take longer. Some particular problems may be encountered: it may be necessary to undertake an osteotomy of the tibial tuberosity or a V-Y quadriceps plasty. Malrotation of the proximal part of the tibia may be present and there may be a deficiency of the tibial plateau. This may influence patellar tracking leading to subluxation or rotatory instability.

The results after a high tibial osteotomy have continued to improve;¹⁷ Odenbring et al¹⁵ found that 75% of patients under the age of 50 years with early medial osteoarthritis had a good result at 11 years after tibial osteotomy. New techniques such as hemicallotasis may improve these results.

The results in knees which have been corrected to a few degrees of valgus show that only 5% require revision by ten years.¹⁵ The need for conversion of a failed osteotomy to an arthroplasty is diminishing,¹⁸ indicating an improvement in operative technique.

We did encounter some more, but not significant, revisions of the prosthesis after total arthroplasty following upper tibial osteotomy, but two of these patients pursued very active occupations.

Tibial osteotomy is important in providing sufficient pain relief in the younger patient to delay or eliminate the need for knee arthroplasty. In our series, there was a mean delay of ten years before arthroplasty, which is longer than that reported in other studies.¹ Our patients were active, and the risk of early prosthetic failure would probably be higher than usual if they had been treated from the beginning by knee arthroplasty.¹⁴

Tibial osteotomy is worthwhile in young patients with osteoarthritis of the knee. Our results show that revision of a failed high tibial osteotomy to a total knee arthroplasty is an effective procedure.

This study was supported by Lund University Medical Faculty, Stiftelsen för bistånd åt vanföra i Skåne, Läkaresällskapet, Nutek, konung Gustav V's 80-årsfond, and the Medical Research Council project 09509.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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