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USE OF A GUIDE INSTRUMENT FOR COMPARTMENTAL KNEE ARTHROPLASTY

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To improve the positioning of the tibial component in compartmental knee arthroplasty a guide instrument was introduced. With the guide instrument the position in the frontal plane significantly improved from a mean medial slope of 10 degrees to 2 degrees. In the sagittal plane the change from a mean posterior slope of 5 degrees to 3 degrees was insignificant. The mean value for the Hip-Knee-Ankle angle (HKA) (ideal 180 degrees) was 186 degrees after "free-hand" operation and 183 degrees with the modified operative technique. Thus, it is possible with the aid of a guide instrument to improve the precision in compartmental knee arthroplasty.

Key words: compartmental arthroplasty; guide instrument; knee; mechanical axis; operative technique; position of endoprosthesis; radiography

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The resurfacing endoprostheses of the compartmental type have been in use since the early seventies. Yet their role in the treatment of gonarthrosis, especially as a unicompartmental arthroplasty, is still under debate. Thus, Marmor (1973, 1977 and 1979), Engelbrecht et al. (1976) and Larsson & Ahlgren (1979) have reported good results, as have also Skolnick et al. (1975) and Dolibois & Mallory (1976) in smaller investigations. On the other hand, Insall & Walker (1976), Laskin (1978) and Insall & Aglietti (1980) have reported poor results and abandoned unicompartmental endoprostheses in favour of bi- or tricompartmental prostheses.

Compartmental arthroplasty has been in use for a long time in the treatment of gonarthrosis at the Department of Orthopaedic Surgery, University Hospital of Lund, Sweden, and the results of the first 102 knees, operated upon during the period October 1974 through June 1977, are favourable (Jónsson 1981). According to the national survey of knee arthroplasties conducted by the Swedish Orthopaedic Society during the years 1976–1980 more than half of the 2000 arthroplasties performed in Sweden for the treatment of gonarthrosis were of the unicompartmental type and these have the lowest complication rate of all prostheses (Bauer et al. 1980).

The present paper deals with the technical aspects of the use of the unicompartmental arthroplasty in medial gonarthrosis. During recent years many authors have emphasized the importance of an exact operative technique to achieve correct prosthetic placement in knee arthroplasty. In particular the importance of surgical training has been stressed. Despite efforts to place the tibial component parallel to the transverse plane free-hand, failures, however, do occur.

In the middle of 1977 we started to use a modified guide instrument, derived from the Lotus prosthesis, in order to obtain a better positioning of the tibial component and at the same time we changed the operative technique.

The main purpose of this report is to analyse the immediate postoperative position in two different prospective series where surgery in series

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A was performed using only the instruments of the standard Marmor equipment (Richard's Modular Knee) and in series B with the help of a guide instrument.

PATIENTS AND METHODS

Series A consists of 31 consecutive medial arthroplasties performed in 1975–1976 with the operative technique described by Marmor (1973). A total of 34 unicompartmental arthroplasties had been performed prior to the beginning of the study and thus the surgeons were familiar with the technique. The 31 knees belonged to 20 women and 11 men (from Jónsson 1981). Fourteen arthroplasties were performed on the right knee and 17 on the left. The age range was 59–88 years with a mean of 71 years. The medial arthrosis was graded according to Ahlbäck (1968); there were no knees in grade I, one in grade II, 17 in grade III, 7 in grade IV and 6 in grade V.

Series B includes 33 consecutive medial arthroplasties operated on during the year 1978 using the guide instrument. There were 29 women and 4 men. The age range was 53–84 years at the operation with a mean of 68 years. Sixteen arthroplasties were performed in the left knee and thus 17 were right-sided. The grading of the arthrosis was none grade I, 5 grade II, 21 grade III, 6 grade IV and 1 grade V.

The indication for medial arthroplasty was in both these series symptomatic gonarthrosis for at least 1 year and the main indication in all cases was pain on walking. The grade of arthrosis was mainly II–IV. During the first series the indications for this type of surgery were rather liberal even in grade V. The limitations of the technique were unknown and the surgeons hesitated to use the only other prosthesis available at the clinic at that time, the hinge device, because of poor results and a high frequency of serious complications. In the latter series, grade V arthrosis was as a rule not treated with this technique though we had not yet started to use our present prosthesis, for advanced medial gonarthrosis, viz. the HSS total condylar endoprosthesis. The presence of a rather large varus or flexion deformity of the knee did not constitute a contraindication for a unicompartmental arthroplasty. The important factor was that only the medial tibio-femoral compartment was affected by the arthrosis.

The preoperative X-ray examination was performed in a standing position with weight-bearing on both legs and with varus and valgus stress for a more certain evaluation of the tibio-femoral articulations (Norman 1974). The knees were classified into Ahlbäck's five grades ranging from joint space narrowing to large bone deformity (Ahlbäck 1968). Postoperatively the angle between the short anatomical axis of the tibia and the tangent of the articular surface of the prosthesis was determined in AP (the medial angle) and lateral (the posterior angle) views. At the follow-up a whole-leg examination including the hip and the ankle joint was performed with the patient standing only on the examined leg, using a focus distance of 2 meters. This frontal exposure was taken at an angle of 90° from a true side exposure determined by the tangential appearance of the posterior aspects of both femoral condyles registered by fluoroscopy. From this whole-leg examination the Hip-Knee-Ankle (HKA) angle was measured as the lateral angle between the lines from the tibial eminence to the centres of the femoral head and the talo-crural joint, respectively (Egund & Norman 1979). In a few cases not all of the roentgenographic examinations were done (see Table 1).

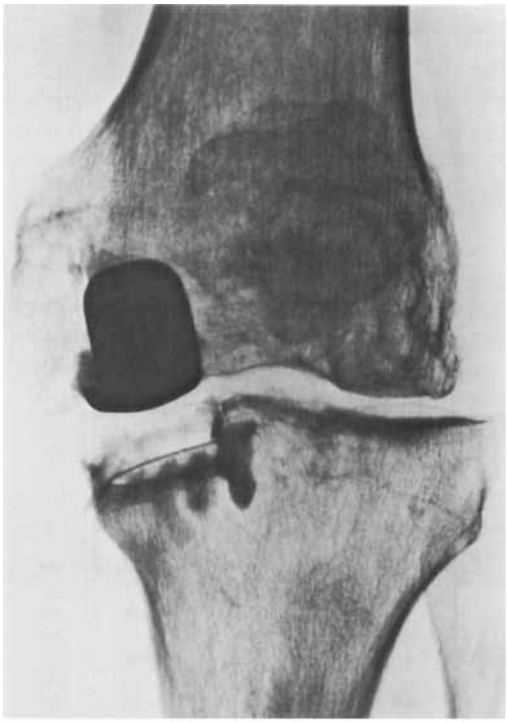
The operation was performed through a single medial parapatellar incision. In series A all knees were operated on according to the original technique described by Marmor (1973) for his modular knee. The proximal tibia was prepared with a power instrument leaving a rim of cortical bone intact; the tibial component thus lies only on cancellous bone. At least three cement pegs were stabilized by the peripheral cortical bone. The original marking templates and other instruments from the standard equipment of Richard's modular knee were used. Usually no release of contracted joint capsule or collateral ligament was done (Figure 1).

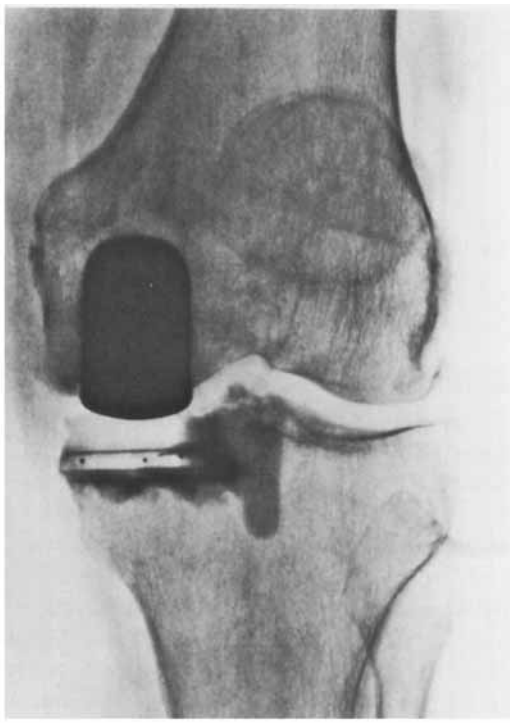
In series B we changed our operative technique and using a positioning jig (modified from the French Lotus prosthesis) (Figure 3) made an L-shaped resection of the proximal tibia. The contracted capsule and the deep portion of the medial collateral ligament were always released. A trial prosthesis of sufficient height to bring the extremity into the intended position was put in, and then the bed for the femoral component was prepared trying to obtain the best possible congruence between the femoral and tibial components (Figure 2).

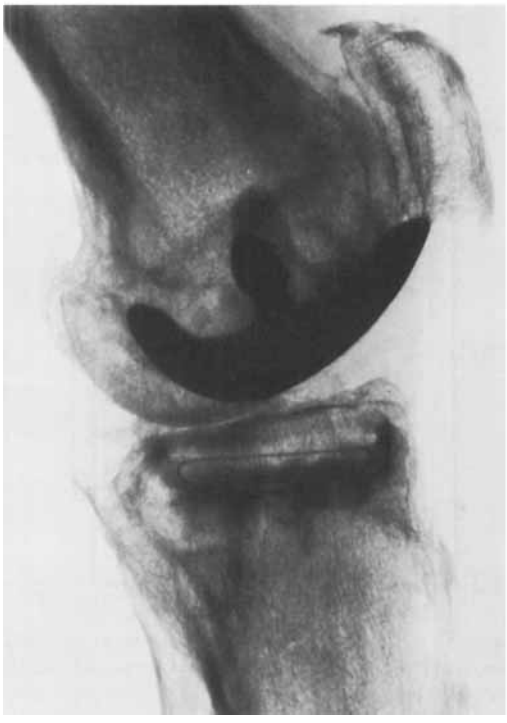
Table 1. Roentgenographic determination of tibial component position and mechanical axis of the lower extremity in unicompartmental arthroplasty performed free-hand (Series A) and with the guide instrument (Series B). Statistical analysis with Student's t-test of series A versus series B

Parameter	Series A (degrees)	Significance	Series B (degrees)
Position in frontal plane	80.4±1.0 (n=31)	***	87.6±0.6 (n=32)
Position in sagittal plane	85.4±1.4 (n=31)	N.S.	87.1±0.9 (n=31)
HKA angle	186.3±1.0 (n=25)	*	183.3±1.0 (n=33)

Values = mean ± SEM. Number of observations in parentheses.
***$P < 0.001$, *$P < 0.05$, N.S. $P > 0.05$.







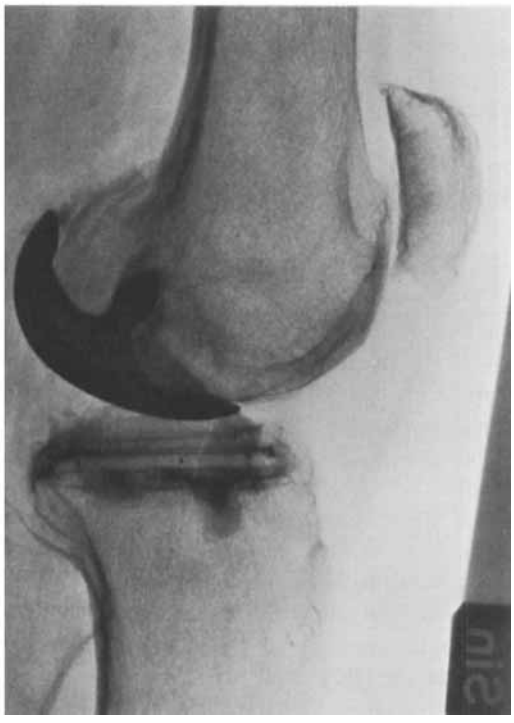


Figure 1. A medial unicompartmental arthroplasty with Marmor's technique.

Figure 2. A medial unicompartmental arthroplasty performed with the aid of the guide instrument.

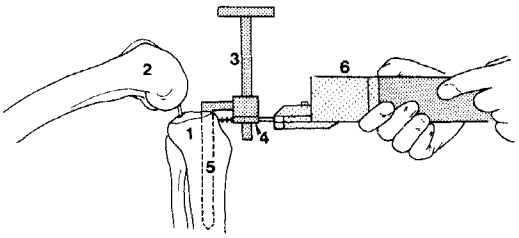


Figure 3. Guide instrument for compartmental knee arthroplasty.
1 = Tibia *4 = Saw-slit*
2 = Femur *5 = Intramedullary stem of the guide*
3 = Guide *6 = Power saw.*

RESULTS

The position of the tibial components was determined by radiographs taken in the antero-posterior view and in the lateral view in relation to a short anatomical axis of the tibia. In series A in the antero-posterior view the tibial components were all sloping medially by an average of 10° from the horizontal position and thus the relation between the tibial component and the axis of the tibia was 80°; range 68–90° (Table 1, Figures 1 and 4). In series B the tibial components were sloping medially or laterally. The mean deviation from the optimal 90° was 2° and thus the angle between the tibial component and the axis of the tibia was on average 88°; range 80–96° (Table 1, Figures 2 and 4). This difference between series A and B is statistically significant ($P < 0.001$).

The position of the tibial component in relation to the tibial axis on the lateral view showed in series A both forwards and backwards sloping with the mean deviation from 90° being a 5° backwards tilt with great variations (range 64–103°). In series B the tibial component was sloping backwards 3° on average and the variations were smaller (range 77–96°). The difference is not statistically significant (see Table 1 and Figures 1, 2 and 4). The differences found between series A and B in the frontal and sagittal position were also unchanged when knees of grade V arthrosis were excluded.

A standing whole-leg examination including the hip, the knee and the ankle joint was obtained to define the HKA angle of the leg. In the normal joint this angle is supposed to be 180°. In knees with a varus deformity the angle increases and in knees with valgus deformity it decreases. At follow-up in series A the mean HKA angle was 186° (range 175–193°) and in series B 183° (range 173–198°). Assuming that the normal alignment in a knee is 180° the average undercorrection of the knees in series A was 6° and in series B it was 3°. This difference is almost significant ($P < 0.05$, Table 1).

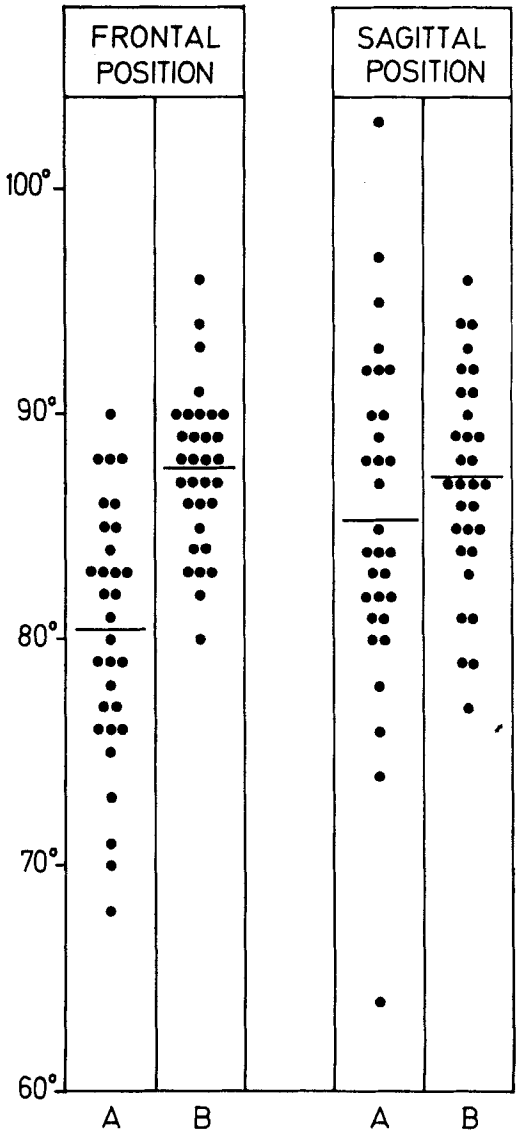


Figure 4. Roentgenographic determination of tibial component position in the frontal and the sagittal planes after unicompartmental arthroplasty performed free-hand (A) and with the guide instrument (B). Each dot represents one patient. Horizontal line indicates the mean values.

DISCUSSION

During recent years many authors have emphasized the importance of an exact operative technique to achieve correct prosthetic placement in knee arthroplasty. Furthermore some of these reports have also stressed the importance of adequate correction of the deformity and a proper reconstruction of the mechanical axis (Maquet et al. 1967) of the leg (Kagan 1977, Lotke & Ecker 1977, Ducheyne et al. 1978, Lacey 1978, Cartier 1979, Jónsson & Lindstrand 1980, Andersson & Herberts 1980, Rand & Coventry 1980).

Marmor (1979) recommends that the tibial component should be placed on the cancellous bone where the tibial plateau has been deepened approximately 3 mm leaving a good retaining rim of cortical bone around the periphery. Femoral and tibial templates are used as positioning instruments with the guidance being limited to the condyles in the operation field. Likewise, the St. Georg and Savastano unicompartmental knee endoprostheses have such instruments. For the Polycentric, Liverpool and Manchester knees local templates for the femoral and tibial components are used in association with a guide instrument for alignment of the components with respect to each other but this does not determine the positioning of the components in relation to the long axes of the femur and tibia (Gunston 1971, Cavendish & Wright 1978, Shaw 1978). For the French Lotus prosthesis there are guiding instruments for the femur and tibia but they do not determine the congruence between the two components. There is, however, no report of the use of this equipment.

The various reports of the results of the use of unicompartmental endoprostheses usually do not analyse failures due to technical problems such as inadequate positioning of the two components or poor congruence between them. Insall & Walker (1976) and Laskin (1978) have no such technical explanation for their many failures. In a material from our own clinic Jónsson (1981) found, in 102 consecutive cases, 15 failures where one main cause was malpositioning of the prosthetic components and medio-lateral instability. Furthermore, Jónsson showed that the position of the tibial component varied greatly. It mostly tilted towards the periphery and at the same time there was a persisting varus deformity. Obliquity of the tibial component was assessed as being a factor contributing to the complications in several cases. The medially sloping component probably maintains the preoperative translation between the femur and the tibia and can even exceed this and thus cause instability and poor alignment between the components. As the translation is more common in the later stages of gonarthrosis an obliquity of the tibial component probably is more harmful for these patients in the long run.

In the present two series operated by "free-hand technique" (series A) and with the aid of a guide instrument (series B) the position of the tibial components is closer to the physiological one when using the guide instrument (series B). When the free-hand technique is used the tibial component has a greater tendency to slope medially and posteriorly. Furthermore, the varus deformity has been corrected to a greater extent in series B. This is mainly explained by a change in the operative technique. A good positioning with the free-hand technique is not easy as the orientation in the operation field is difficult. This is probably especially true for an inexperienced surgeon.

In order to compare the results of the different operative techniques the cases in series A are from a period when the technique had been in use at the clinic for about a year. Likewise series B is chosen from a period when the guide instrument had been in use for a similar time. In both series the operations were performed by only a few surgeons familiar with knee arthroplasties. This was done to avoid favouring either of the methods.

Rand & Coventry (1980) have reported 15 patients sustaining stress fractures of the tibia after geometric and polycentric total knee arthroplasty. The chief causes of the stress fractures were axial malalignment and incorrect component orientation compared with a control material. In a series of Freeman prostheses, Andersson & Herberts (1980) had less complications in the long run when the mechanical axis of the leg was reconstructed correctly. Kagan (1977), Ducheyne et al. (1978) and Freeman et al. (1978) also found a good alignment of the

extremity of importance when analysing failures in their series.

It is possible with the aid of the guide instrument to obtain a more correct positioning of the tibial component in compartmental resurfacing arthroplasty. With an adequate operative technique it is also possible to reconstruct the mechanical axis of the leg in order to obtain a more physiological position of the leg. An increasing number of orthopaedic surgeons will be performing total knee arthroplasties in the future. It is extremely important therefore that operative techniques facilitated by guide instruments are more frequently used to secure the correct position of the endoprosthesis. More adequate guide instruments are under development but there are still a great number of orthopaedic surgeons who regard the performance of operations of this kind in the same way as a sculptor creating a work of art. Let us not forget the spirit of the artist but at the same time try to achieve the same level of precision in our work as in the making of modern industrial products.

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