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THE ATTENBOROUGH TOTAL KNEE PROSTHESIS

Results of 25 Operations Evaluated According to Two Different Assessment Systems

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The Attenborough stabilized gliding total knee prosthesis was used in cases of severely damaged, highly unstable or deformed knees. Twenty-five operated cases were followed for 1½ years (range 12–28 months).

The results were assessed according to two different knee evaluation systems: The Lotke & Ecker knee evaluation index and the knee function assessment chart (BOA chart) suggested by the British Orthopaedic Association. The overall results were excellent or good in 84 per cent (21/25) of the cases according to both systems, but when considering the improvement in individual clinical features the BOA chart results were more optimistic. Neither of the systems takes into consideration that the results are influenced by possible disorders in other joints. If only the function of the knees was being judged the results of the operations with the Attenborough prosthesis were excellent or good in 96 per cent (24/25) in this series In general the results were found to be as good as those obtained in less disabled knees treated with compartmental prostheses. As more extensive surgery and bone resection is needed for insertion of the Attenborough prosthesis compared with compartmental prostheses, its use should be restricted to severely damaged knees which would otherwise be treated with a hinged prosthesis or an arthrodesis.

Key words: assessment schemes; knee arthroplasty; prosthetic device

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An attempt has been made to solve the problem of severely painful, unstable and deformed knees by the use of hinged knee arthroplasties with long intramedullary stems. The only other alternative so far has been knee arthrodesis. Several evaluations of the results of these operative procedures have shown that sooner or later loosening of the prosthetic device occurs (Insall et al. 1976, Deburge et al. 1979, Murray 1980, Bargar et al. 1980 and Hui & Fitzgerald 1980). A knee arthrodesis at this point is a difficult task as a rather large amount of bone has been resected to insert the prosthetic device in the first place. An alternative to the single axis hinged type of knee prosthesis is the multicentric gliding stabilized total knee prosthesis. In some of the prostheses of this type (Matthews et al. 1973, Sheehan 1978) the femoral and the tibial components are directly interlocked. This might apply traction forces to the prosthetic components during motion of the knee. The Attenborough prosthesis has no such linkage (Attenborough 1976) and was chosen as it offers, apart from a nearly normal range of mobility in all planes, an inbuilt stability through an omnipotent metal rod ligament which during flexion and extension of the knee pumps up and down inside the tibial component, while being connected to the centre of the femoral component through a ball joint. This arrangement means that fully extended the knee is absolutely stable but with subsequent flexion the prosthesis allows an imitation of the "looseness" of a normal knee. Little bone resection is needed to insert the prosthetic device, as it is to a certain

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extent surface bearing, and the medullary stems are relatively short.

Thus this type of knee prosthetic device was tried in a prospective series in order to find out if it was a worthwhile alternative to the hinged type of stabilized knee prosthesis.

In evaluation of the knees to be operated on two different knee assessment systems were used in order to be able to compare the results with several other evaluations, and at the same time to compare the value of these two different schemes.

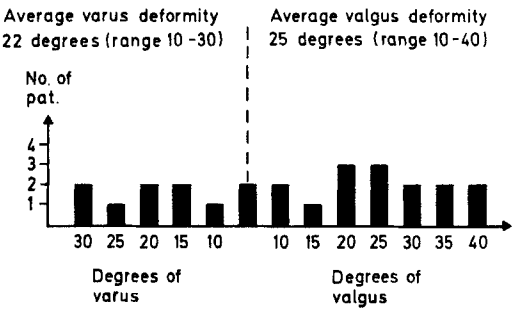

Figure 1. Varus and/or valgus deformity in 25 patients. (17 patients fulfilled the operative criteria in this respect).

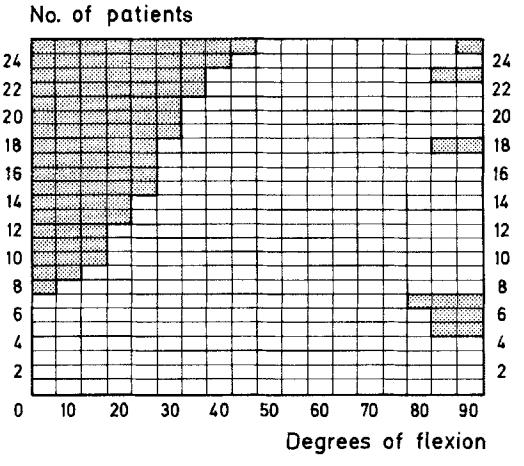

Figure 2. Flexion arch between 0–90 degrees in 25 patients. (Average 69 degrees, range 40–90 degrees). Shaded areas indicate defects in flexion. (10 patients fulfilled the operative criteria in this respect).

PATIENTS AND METHODS

During the period December 1977 to April 1978, 25 patients, 19 women and 6 men, with an average age of 66 years (range 42–80 years) and with severe pain, instability and/or deformity of the knees, were operated on and fitted with the Attenborough knee prosthesis.

The diagnosis of the disorder in 19 cases was rheumatoid arthritis, in five osteoarthritis and in one osteochondrosis. Fifteen of the knees had been operated on previously on at least one occasion; eleven synovectomies, one high tibial osteotomy, and three bicondylar resurfacing prostheses (inserted 3, 4 and 6 years earlier).

Nineteen patients had spontaneous pain, and all patients able to stand had disabling pain on weight-bearing. Seven patients were confined to wheelchairs and nine managed to walk using canes or two sticks. Nine patients could walk with the support of one stick only. Of the patients able to walk the walking distances are shown in Table 1.

The indication for operation with the Attenborough prosthesis was in all cases disabling pain combined with instability when weight-bearing or fixed deformity in varus or valgus of 20 degrees or more – or flexion deformities of 25 degrees or more within the range 0–90 degrees. The average varus deformity in eight patients having this deformity was 21 degrees (range 10–30°). The average valgus deformity in 15 patients having this deformity was 25 degrees (range 10–40°). The deformity in varus or valgus and flexion deformities within a 0–90 degrees flexion arch are shown in Figures 1 and 2, respectively.

In all cases the medial parapatellar incision was used. Preparation of the knee joint was done according to the Attenborough instructions (Attenborough 1976). All operations were performed in a Charnley Howorth clean air unit using a pneumatic tourniquet. Twenty patients were operated on under spinal or epidural analgesia and five under general anaesthesia. Prophylactic antibiotics were not used. Six different surgeons were involved in the operations of this series.

Active flexion and extension exercises were started in bed as soon as the patients could manage them. Walk-

Table 1. Walking distances of 18 patients able to walk preoperatively

	<50 metres	50<100 metres	100<500 metres	500<1000 metres	Total
No. of patients	7	6	4	1	18

*Table 2. Knee evaluation index according to Lotke & Ecker (1977)**

I. PAIN (possible 36 points)	
Pain at rest	
None	9
Mild	6
Moderate	3
Severe	0
Pain while walking	
None	27
Mild	18
Moderate	9
Severe	0
II. FUNCTION (possible 34 points)	
Use of aids	
None	18
Cane occasionally	15
Cane always	12
Crutches	9
Two crutches or canes	6
Walker	3
Wheelchair	0
Walking distance	
Unlimited	10
Minimum limitation	8
5–20 blocks	6
1–5 blocks	4
Indoors only	2
Bed to chair	0
Ability to rise from chair	
With ease	6
Minimum difficulty	4
Moderate difficulty	2
Unable to do so	0
III. EXAMINATION (possible 30 points)	
Flexion contracture	
0 degrees	9
0–2 degrees	8
3–5 degrees	7
6–10 degrees	6
11–15 degrees	5
16–20 degrees	4
21–25 degrees	3
26–30 degrees	2
31–45 degrees	1
More than 45 degrees	0
Flexion arch between 0–90 degrees multiplied by 0.1 (possible 9 points)	0–9
Ligament stability medial or lateral (possible 5 points)	
Normal	5
1–5 degrees	4
5–10 degrees	3
10–15 degrees	2
15–25 degrees	1
More than 25 degrees	0
Angular deformity varus or valgus (possible 7 points)	
None	7
1–5 degrees	6
5–10 degrees	4
10–20 degrees	2
More than 20 degrees	0

* Normal knee = 100 points.

ing with weight-bearing and canes was instituted from the first postoperative day. When the patients could manage this procedure, walking with sticks was allowed. Sutures were removed 12 days postoperatively.

The range of knee mobility and instability was measured preoperatively and at follow-up with a goniometer (International Standard goniometer).*

An estimation of the knee function was made preoperatively and at follow-up according to the Lotke & Ecker knee evaluation index (Lotke & Ecker 1977) (Table 2) which is comparable with other evaluation schemes which are slight variations of the Larson knee score system (Wilson et al. 1980, Evanski et al. 1976, Insall et al. 1976).

In order to compare results with other publications using the British Orthopaedic Association's knee function chart (Aichroth et al. 1978) an estimation was also done according to this scheme (Table 3). At the same time the results of the two evaluation systems were compared with one another in order to estimate what differences there were if any.

Preoperatively all patients were evaluated radiologically with X-rays of the knees in the lateral and the anteroposterior projections during weight-bearing. The same evaluation was used postoperatively and at follow-up, this time combined with special pictures of the patella in order to check for the presence of patella luxation or subluxation. Special attention was given to conflicting angulation between the stem of the prosthetic device and the direction of the femoral and the tibial medullary canals in order to estimate whether the functional results were dependent on an exact positioning of the prosthetic device or whether the prosthesis could tolerate a certain amount of surgical inaccuracy. Radiolucent zones around the cement or the metal were measured postoperatively and at follow-up in order to see if any loosening of the prosthetic device had

* Cat. No. 238 S.F.T.R., Orthopedic Equipment Co., Bourbon, Indiana, USA.

Table 3. Clinical assessment preoperatively and at follow-up according to the British Orthopaedic Association knee assessment chart (Aichroth et al. 1978) in 25 patients

Preoperative assessment	Grade of assessment										
	0		1		2		3		4		
Clinical features	No. of knees	Per cent	No. of knees	Per cent	No. of knees	Per cent	No. of knees	Per cent	No. of knees	Per cent	Total
Pain			18	72	7	28	–	–	–	–	25
Ability to walk	7	28	4	16	10	40	3	12	1	4	25
Walking aid	7	28	9	36	8	32	–	–	1	4	25
Gait			–	–	4	22	6	33	8	44	18
Flexion deformity			8	32	3	12	6	24	8	32	25
Maximal flexion			6	24	9	36	6	24	4	16	25
Extension lag			–	–	6	24	14	56	5	20	25
Valgus angle			8	32	7	28	6	24	4	16	25
Varus angle			2	8	2	8	4	16	17	68	25
Get out of chair			7	28	15	60	3	12	–	–	25
Climb stairs			8	32	16	64	1	4	–	–	25

Follow-up assessment	Grade of assessment										
	0		1		2		3		4		
Clinical features	No. of knees	Per cent	No. of knees	Per cent	No. of knees	Per cent	No. of knees	Per cent	No. of knees	Per cent	Total
Pain	–	–	1	4	–	–	4	16	20	80	25
Ability to walk	–	–	1	4	1	4	10	40	13	52	25
Walking aid			1	4	7	28	4	16	13	52	25
Gait			–	–	1	4	4	16	20	80	25
Flexion deformity			–	–	–	–	3	12	22	88	25
Maximal flexion			–	–	2	8	8	32	15	60	25
Extension lag			1	4	–	–	2	8	22	88	25
Valgus angle			–	–	–	–	2	8	23	93	25
Varus angle			–	–	–	–	–	–	25	100	25
Get out of chair			1	4	1	4	9	36	14	56	25
Climb stairs			1	4	1	4	15	60	8	32	25

occurred. Follow-up was attended by all patients every 6 months post-surgery.

For statistical analysis of the results the Chi square test was used. The level of significance used was $P < 0.05$.

RESULTS

The period of hospitalization was 21 days (range 14–42 days). Deep infections were encountered in 8 per cent (2/25) of the cases. The deep infection in one of the cases was primary and in the other a late infection occurred half a year after surgery. This patient had had an infection in the same knee 5 years earlier; exactly the same bacteria was isolated on both occasions. The infection therefore could have been latent. No superficial infections were encountered, and there were no clinical venous thromboses.

Evaluation of the 25 knees at follow-up 1.5 years post-surgery (range 12–28 months) showed that all the patients could walk, 48 per cent (12/25) without aids, 28 per cent (7/25) occasionally used one stick, 16 per cent (4/25) always used one stick and 8 per cent (2/25) always used two sticks. Five patients had residual knee pain (20 per cent). One had severe pain when walking (4 per cent). This was the patient with a primary deep infection. The other four pa-

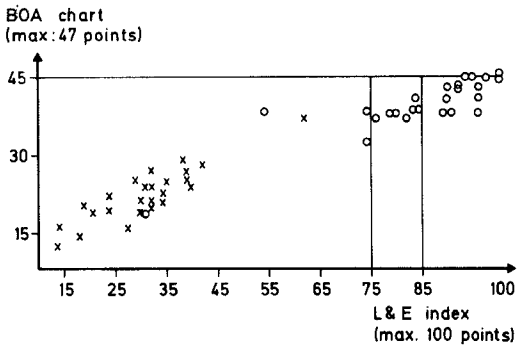

Figure 3. Comparison of results of 25 knees assessed according to the British Orthopaedic Association's knee function chart (1978) (BOA chart) and according to the Lotke & Ecker knee evaluation index (1977) (L & E index). Preoperative assessment (×); follow-up assessment (○).

tients had occasional mild pain (16 per cent). One of these was the patient with the late infection. The other three (3/25; 12 per cent) all had patellar problems. One of them had a marked dislocation of the patella when knee flexion exceeded 45 degrees. The two others had only subluxations.

According to the Lotke & Ecker knee evaluation index (Table 2), where 100 points equals a normal knee, the average preoperative score was 31 points (range 13.5–62 points) and at follow-up after 1.5 years (range 12–28 months) 83 points (range 30–100 points). Fifty-six per cent (14/25) of the patients obtained scores from 85–100 points, which were considered excellent results. A further 28 per cent (7/25) obtained good results with scores ranging from 75–84 points. Fair results were found in 8 per cent (2/25) with scores between 65 and 74 points (both patients obtained 74 points), and finally poor results were encountered in 8 per cent (2/25) of cases with scores below 65 points.

Table 3 shows the preoperative results and results at follow-up according to the assessment chart suggested by the British Orthopaedic Association (Aichroth et al. 1978), which classifies the results into grades for the different clinical parameters. As can be seen most knees moved from grades 0, 1 and 2 to grades 3 and 4.

A comparison of the results according to the two evaluation systems used in this series is demonstrated in Figure 3. It is evident that the overall results preoperatively and at follow-up compare well in the two systems, but also that the Lotke & Ecker index offers a more individual judgement. In order to find out whether the two evaluation systems favoured the same parameters equally, the percentages gained within different categories were assessed and compared as demonstrated in Table 4. It was found that the BOA chart gave the more optimistic view (Chi square test: $P < 0.05$), except as regards walking aids, flexion

Table 4. Comparison of the improvement gained according to the Lotke & Ecker evaluation knee index (1977) and the British Orthopaedic Association's knee function assessment chart (1978)

	BOA chart			L & E index		
Clinical features	Preop. Grade 1+2 Per cent	Follow-up Grade 1+2 Per cent	Gained Per cent	Preop. max. points Per cent	Follow-up max. points Per cent	Gained Per cent
Pain	100	8	92*	13	78	65*
Walking aid	96	32	64	40	83	43
Walking ability	84	8	76*	24	63	39*
Get out of chair	88	8	80**	42	73	32**
Flexion deformity	44	0	44	56	89	33
Flexion arch	60	8	52**	78	96	22*
Angulation (varus or valgus)	76	0	76	19	89	70

* Chi square test significant, $P<0.05$.
** Chi square test significant, $P<0.01$.

Table 5. Degrees of varus or valgus angulation of the femoral or tibial stem prostheses in relation to the femoral or the tibial intramedullary canals

Clinical result	points	0–4 degrees	5–7 degrees	8–10 degrees	11–15 degrees	15 degrees	Total no. of knees	Per cent
		No. of knees						
Excellent	85–100	4	7	2	1	0	14	56
Good	75–84	2	0	3	1	1*	7	28
Fair	65–74	0	0	2	0	0	2	8
Poor	<65	0	0	0	2	0	2	8
Total no. of knees		6	7	7	4	1	25	100
Per cent		24	28	28	16	4		

Chi square test: No significant difference between groups.

* The femoral stem had a valgus angulation of 17 degrees in the antero-posterior view. Cement fracture at the middle of the tibial prosthesis was encountered.

Figure 4a. Preoperative X-rays: Left knee of a 72-year-old woman with severe pain at rest and when weight-bearing. She managed to walk only short distances with the aid of two crutches. The knee had no ligamentary function at all. The preoperative score according to Lotke & Ecker (1977) was 36.5 points.

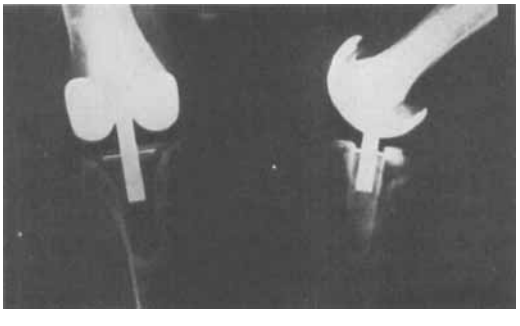

Figure 4b. X-rays at follow-up: The same knee as above 2 years postoperatively. The patient had no pain at all. She was able to walk at least 2 kilometres without any walking aid. There was neither residual angulation or instability of the knee nor subluxation of the patella. The functional score at follow-up was 95 points.

deformity and angulation, where the assessment of the two systems did not differ significantly.

The four patients with fair or poor results were reviewed in order to find possible explanations for the failures.

One of the poor results was the knee with a primary deep infection (as mentioned below the prosthetic device was also radiologically loose). The other unsatisfactory knees, according to the knee scheme evaluations, were well-functioning, pain-free knees obtaining mediocre ratings because of the influence of other malfunctioning joints on the pain score, the use of aids, the walking distance, and the ability to rise from a chair and climb stairs.

Thus in 96 per cent (24/25) of the knees the results were actually excellent or good.

The radiological measurements of the positioning of the prosthetic device and its possible influence on the clinical results is demonstrated in Table 5. It was found that even angulations between the stem of the prosthetic device and the femoral or tibial medullary canals of up to 15 degrees in varus or valgus deviation were compatible with good clinical results. Loosening of the prosthetic device was found in 4 per cent (1/25) (primary deep infection). Intermittent radiolucent zones around the cement were found in 4 per cent (1/25) (late infection occurring after half a year). Radiolucent zones around the cement of less than a millimeter (with no further development within the time of observation)

were found in 16 per cent (4/25) of the cases. Figure 4a demonstrates the preoperative X-rays of an average knee in this series. Figure 4b demonstrates the result at follow-up 2 years postoperatively.

DISCUSSION

The results of the operations in this series compare well with those obtained in patients treated with resurfacing knee protheses (Evanski et al. 1976, Cavendish & Wright 1978, Shaw & Chatterjee 1978 and Marmor 1979), though the initial degree of disability in these patients was far less.

When judging the results it should be borne in mind that no detailed evaluation scheme takes into consideration that the patients are often multi-joint handicapped. Thus, in three of the four cases with fair or poor assessment results, only one was directly related to the function of the operated knee, the other results were mainly due to interference caused by disorders of other joints.

The 4 per cent primary infection rate seems to be within the limits of what is the accepted risk for this type of prosthetic device (Hui et al. 1980, Bargar et al. 1980, Deburge et al. 1979, Kaufer & Matthews 1978, Attenborough 1978, Sheehan 1978, Lettin et al. 1978, Insall et al. 1976).

The Attenborough prosthesis has proved to be efficient in reducing pain and deformity in severely damaged knees. It has also reduced the need for walking aids and has increased walking distances. In this series 28 per cent (7/25) of the patients had been confined to a wheelchair preoperatively compared with none at follow–up. This percentage of wheelchair patients is higher than in any other recent series (Attenborough 1978, Sheehan 1978, Lettin et al. 1978 and Vanhegan et al. 1979). Residual pain caused by subluxation of the patella was found in 12 per cent (3/25) of cases. This compares with results from other series (Freeman et al. 1978, Lettin et al. 1978, Sheehan 1978 and Vanhegan et al. 1979. Though the problem of subluxation of the patella has no connection with the initial valgus angle (Sneppen et al. 1978), Freeman's suggestion (1978) of using lateral release in cases of severe valgus angulation should be considered more often.

A survey of reports evaluated according to the BOA chart (Sheehan 1978, Attenborough 1978, Lettin et al. 1978 and Vanhegan et al. 1979) shows that maximum points were always given postoperatively for reduction of angulation with the comment: the prosthesis does not allow any varus or valgus deviation. This is probably true when prostheses with long intramedullary stems are considered, but with the Attenborough prosthesis, with its short intramedullary stems, this is only true if the prosthetic device is correctly inserted in the medullary canals. The results of this series show, however, that rather wide margins are tolerated, which does not seem to be the case with a similar unhinged prosthetic device (Kaufer & Matthews 1979). Thus, the Attenborough stabilized gliding knee prosthesis has so far proved to give good results. However, as the majority of knees in need of a prosthetic device function satisfactorily after treatment with resurfacing prostheses, the use of the Attenborough knee prosthesis should be restricted to severely damaged, angulated and unstable knees which otherwise would be treated with a hinged prosthesis or an arthrodesis.

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