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GUEPAR hinge knee prosthesis

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ABSTRACT

Early and late results of the GUEPAR hinge knee prosthesis were evaluated on a series of 184 operations performed before January 1st, 1974. There were 3 immediate deaths and 26 before 5 years. Nineteen prostheses were removed. One hundred and twenty-six knees had degenerative osteoarthritis, 52 rheumatoid arthritis. Twenty-two had been operated on before. Patellar displacement, present in 27% of the cases, was the most frequent cause of complaint: pain or instability, proportional to the severity of displacement, made re-operation necessary in 10% of the patients. Addition of a patellar prosthesis was the most successful treatment as far as pain is concerned: it is probably advisable as a primary procedure. Deep infections occurred in 8.3% of the cases, infrequently after 2 years. Healing was obtained in all cases either by revision or by removal and arthrodesis: but functional results were poor except when fusion was achieved, in half of the cases of arthrodesis. Loosening occurred in 16% of the cases, mainly as a consequence of inadequate technique. It was frequently tolerated: re-operation was necessary in 6% of the total. Late functional results were evaluated in 99 cases with a follow-up of 5 to 8 years. Apart from loosening, the results did not deteriorate. Sixty percent were evaluated as excellent or good, 29% fair, and 11% poor. In consideration of these results, the choice of this prosthesis should be limited to special cases. To prevent complications, the use of a patellar prosthesis, of reinforced models and of cementing under pressure is advisable.

1. Introduction

The GUEPAR hinge total knee prosthesis was first presented during the 1971 Winter Meeting of the French Society of Orthopedic and Traumatologic Surgery (SoFCOT) [2]. Subsequently, there have been reports of complications and initial results from GUEPAR (joint prosthesis implementation and study group: groupe pour l'utilisation et l'étude des prothèses articulaires) members [3,4,7,8,14] and other surgeons [5,11–13,19].

The present study investigated whether prolonged use increased the rate of complications and affected functional results. In the light of our experience, we explain the modifications the GUEPAR has made to its hinge prosthesis and the indications we would recommend.

2. Material and methods

Files were studied for 183 knees (153 patients) operated on using the GUEPAR prosthesis between October 1st, 1970 and December 31st, 1973 in 7 hospital departments.

Fig. 1 shows the distribution by age and gender. Mean overall age was 69.3 years (range, 38–86 years); in case of osteoarthritis (126 knees), it was 73 years, and in rheumatoid arthritis (52 knees) 59.8 years.

Dedicated prostheses for inferior femoral tumor resection were excluded from the present analysis. Twenty-two knees had undergone previous surgery: 2 synovectomies, 2 posterior capsulotomies, 2 patellectomies, 13 tibial osteotomies, 1 femoral osteotomy, 2 MacIntosh partial tibial implants, and 3 hinge prostheses.

The approach (specified in 176 surgeries) was mainly the medial Gernez approach (156 cases), in 22 cases associated to anterior tibial tuberosity osteotomy. Patellotomy was associated in a single step in 10 knees.

Fig. 2 displays follow-up:

- 3 patients died peroperatively or in the immediate postoperative course before awakening. In France, E. Letournel [16] and
J. Duparc [9] pointed out the risk of mortality in this surgery, due to peroperative heart failure or secondary death from fatty embolism. C. Kenesi [14] published an update, reviewing immediate postoperative course in 758 cemented hinge prostheses:

- 23 patients, including 3 with bilateral prostheses, died with their prosthesis in place, at between 6 months and 5 years;
- 17 prostheses were removed within 5 years due to complications;
- 36 knees were lost to follow-up in less than 5 years.

All subsequent mortality and loss to follow-up was included in the study of complications, as follow-up was at least 1 and very often up to 3 years. One hundred and one knees were followed up for at least 5 years, including 23 with > 7 years’ follow-up. Two prostheses were removed later than 5 years.

3. Results

3.1. Complications

The present study focused on patellar problems, aseptic loosening and infection, with a view to analyzing the impact of time on onset and tolerance.

Patellar complications were the most frequent. The problem was two-fold: lateral displacement of the patella, inducing instability, and damage to the posterior patellar joint surface in contact with the trochlear shield of the implant.

After excluding cases of death, early knee fusion, patellectomy and insufficient radiological data, patellar complications were studied in 143 knees.

Lateral displacement of the patella was fairly frequent: 38 cases (27%), with severe subluxation in 22 cases (16%) and dislocation in 16 cases (11%). The rate was somewhat higher in case of preoperative valgus (33%) than varus (22%) or good alignment (22%).

Functional impairment led to revision surgery in only 15 knees (10%). It was related to the degree of lateral displacement: the rate was 2% when the patella was well-aligned or slightly subluxated, 23% when severely subluxated and 50% when dislocated. Etiology was not significantly related to tolerance, as revision rates differed little between osteoarthritis (11%) and rheumatoid arthritis (8%). When functional problems led to revision, this was early: before 1 year in 11 of the 15 cases. Over prolonged follow-up, the rate of major patellar problems did not increase.

Revision surgery consisted in realigning the patella by tibial tuberosity transfer in 13 cases, with associated patellectomy in 1 case. There was 1 deep infection and 1 late infection (following patellectomy). There was only 1 case of secondary patellar dislocation. Recentering the patella abolished or relieved pain in all but 1 case, which required further revision using a polyethylene patellar implant, which completely abolished pain. In the two knees managed without transposition, a patellar implant was used, abolishing pain in 1 case; the result in the other case could not be assessed as such, due to subsequent re-operation for loosening.

Deep infection, as we wrote in 1976, is always dramatic in the postoperative course following hinge total knee replacement, and sadly not exceptional. A series with 2 years’ follow-up that we reported in 1975 [7] showed a 6.6% rate of deep infection. The present series was smaller (180 knees, excluding the 3 cases of early death) but with 1–8 years’ follow-up, and showed 15 deep infections (8.3%): 5 early and 5 “late”. The 5 late infections were diagnosed before 1 year in 4 cases, at 1–2 years in 4, at 2–3 years in 1 and at 4 years in 1. The two cases diagnosed after 2 years involved re-operations following the first revision surgery for a patellar complication.

The present long follow-up thus found no onset of new deep infection beyond 2 years unless in knees re-operated on for other causes. We shall not repeat here the discussion of the causes of deep infection that we presented elsewhere [8], but simply report the results of the reinterventions.

The 5 early infections were in 2 cases managed by attempted primary arthrodesis. One knee failed to achieve fusion; the other achieved fusion after complementary bone graft. Three knees underwent revision surgery, in 1 case early, at 1 month, with complete dry-out resulting in painless 90° flexion; the other two were operated on “too late”, at 3 and 4 months respectively, resulting in failure despite iterative revision; attempted arthrodesis failed in 2 cases.

The 10 late infections were managed by arthrodesis in 5 cases: 3 achieved fusion; 1 failed to achieve fusion and infection persisted at the time of writing; the 5th patient died of a general illness just when fusion appeared to be achieved. Curiously, 5 cases were treated by revision without replacement: in 2 cases persistent fistula led to a poor functional result; in the other 3 cases, the knee dried at 1, 2 and 4 years, respectively.

Outcome in deep infection is thus poor, not so much in terms of infection as such, as only 3 knees showed persistent fistula, as functionally, with only 5 patients able to walk without pain, contention or assistance, including 3 with arthrodesis.
Aseptic loosening was studied at 1 to 8 years’ follow-up, excluding cases of infection: i.e., 165 knees. It was fairly frequent (26 cases; 16%), but paradoxically quite well tolerated, as only 10 knees (6%) underwent surgical revision. Thirteen of the 16 cases without revision had at least 5 years’ follow-up.

Analyzing the cause of loosening reveals several factors:

- etiology: the present series included only 1 case of tubas, associated with very early loosening, but we have other recent examples showing the same pattern of evolution. Loosening rates were slightly higher in rheumatoid arthritis (21%) than in osteoarthritis (13%);
- defective frontal implant positioning is also a likely aggravating factor, although the disparity between the two groups in the present series prevented demonstration: there were 4 cases of loosening in 15 prostheses implanted in varus (27%), 21 in 140 well positioned frontally (15%), and 1 in 7 implanted in valgus (14%);
- although the lack of precise criteria precludes quantification, we have the impression that the main cause of loosening is poor fixation in an enlarged diaphyseal-meta physeal region.

The 10 cases of poorly tolerated loosening underwent surgical revision, 4 at 1–3 years, 4 at 3–5 years and 2 later than 5 years. Surgical reports found 4 cases of isolated tibial component loosening, and 2 of isolated femoral loosening (the only cases in the present series involving fracture of the intramedullary stem in the metaphysis, at 4.5 and 5.5 years’ follow-up). All 10 knees underwent revision: 1 arthrodesis, which achieved fusion; and 9 replacements of the entire implant or of one component.

Functional results at a minimum 5 years’ follow-up

Functional results were assessed in 99 knees conserving the prosthesis, originally implanted for osteoarthritis in 70 cases and rheumatoid arthritis in 29. Results for stability were not analysed as such, except in patellar dislocation, hinge prostheses are not unstable.

The main benefit experienced by the patient was alleviation or abolition of pain (Fig. 3). Pain graded as severe was associated in 6 cases with patellar issues and twice with loosening.

Good range of motion is usually quickly achieved with hinge prostheses. Extension is regularly recovered; in the present series, only 3 knees showed flexion contracture exceeding 10° (1 at 15° and 2 at 20°), whereas preoperatively 21 knees had extension deficits of at least 30° (maximum, 55°). Eight knees were mobilized under general anesthesia; there were 2 failures, with final ROM >30°, but one of these knees had been mobilized too late, at 5 weeks, causing fracture of the tibial tuberosity, which had not initially been sectioned. Final flexion results (Fig. 4) were very favorable, with 81.8% of knees achieving at least 90° flexion (49.5% at least 110°). Analysis of factors affecting flexion found that etiology, age, surgical approach, sectioning of the tibial tuberosity and patellectomy were not determining factors. Poor results were found in two situations:

- infection;
- and severe initial stiffness.

The corollary did not hold: two re-operated infected knees achieved 90° flexion and 5 of the 9 stiff knees with less than 60° flexion recovered at least 100° motion.

Global function results were assessed with the severity adopted in our earlier reports [3] (Table 1). The criteria correspond to minimum requirements: a single negative criterion lowers the global score, which is why Table 2 shows results for pain and flexion that are less excellent than found in Figs. 3 and 4. In some cases, global function could not be assessed due to concomitant joint pathology or deterioration in general health status. For results that could be assessed, 88% were very good, 51% good, 28.8% fair and 11.1%

Table 1

<table>
<thead>
<tr>
<th>Functional assessment criteria.</th>
<th>Pain</th>
<th>ROM</th>
<th>Walking</th>
<th>Stairs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Very good</strong></td>
<td>None</td>
<td>Flexion ≥ 110°</td>
<td>Without cane</td>
<td>Symmetric without assistance</td>
</tr>
<tr>
<td>Good</td>
<td>Fair</td>
<td>Flexion 90° to 110°</td>
<td>Without cane</td>
<td>Descent with assistance</td>
</tr>
<tr>
<td>Occasional</td>
<td>Flexion &lt; 60°</td>
<td>Always 1 cane</td>
<td>Asymmetric with constant assistance</td>
<td></td>
</tr>
<tr>
<td>Considerable</td>
<td>Frequent</td>
<td>Flexion &lt; 60°</td>
<td>2 canes</td>
<td>Asymmetric with constant assistance or impossible</td>
</tr>
<tr>
<td>Fair</td>
<td>Severe</td>
<td>Flexion &lt; 60°</td>
<td>2 canes</td>
<td>Asymmetric with constant assistance or impossible</td>
</tr>
<tr>
<td>Poor</td>
<td>Permanent</td>
<td>Flexion &lt; 60°</td>
<td>2 canes</td>
<td>Asymmetric with constant assistance or impossible</td>
</tr>
</tbody>
</table>
poor. The final Table 3 shows principal factors implicated in non-
satisfactory results.

4. Discussion

Hinge total knee prostheses are clearly non-physiological and change the mechanical behavior of the knee (20). They have the advantage of being fairly easy to fit and of correcting the major deformities and instabilities without risk of ligament lesion. Given their associated complications, do they represent a reason-
able compromise now that considerable progress has been made in the design and implantation technique for semi-constrained non-hinged implants (Freeman, Total-Condylar, RMC)? In analy-
izing the complications encountered in the present series, we shall explain what we did to limit them and shall specify indica-
tions for the GUEPAR prosthesis, analyzing problems according to etiology.

Patellar issues were frequent in the present series and have been reported by all authors using the GUEPAR pros-
thesis [5,11,13,18,19], often with better tolerance than in the present case: Sneppen [19] counted 32 lateral displacements in 50 prostheses, with only 3 painful knees. In the present series, it clearly emerged that tolerance was much better when the patella was aligned on the hinge prosthesis. The rather high rate of only fair results (Table 3), however, was due to patellar pain even when the patella was not displaced. There are several ways of ensuring alignment of the patella on a GUEPAR prosthesis:

- sectioning the lateral retinaculum, mainly in knees with preop-
erative fixed valgus; however, this may cause serious problems in case of large hematoma;
- peroperative attention to positioning in rotation, not leaving the tibial tuberosity lateralized; the tuberosity may be transposed in the same surgical step, but with a risk of aggravating cicatrization problems and thus of infection;
- using a deeper trochlea; Lettin’s experience [15] seems impor-
tant in this respect: by deepening the trochlear groove in a Stanmore hinge prosthesis, he succeeded in preventing patellar dislocation. Since we started using the GUEPAR-2 model, with a deeper trochlea, we have likewise found fewer patellar prob-
lems, although this cannot as yet be quantified as this generation of prosthesis remains to be studied in our group as a whole;
- we now almost systematically use a polyethylene patellar com-
ponent. This provides extra patellar stability, especially in the GUEPAR-2 model, and prevents patellar pain. There have so far been no complications requiring revision surgery. Amstutz’s team [5] have also used this patellar component in recent primary and secondary implantations.

Deep infection is frequent with the GUEPAR hinge prosthesis, with a rate of 8.3% in the present series, 9.8% in that of the Mayo Clinic [11], and 11.1% in that of Insall [13]. Our group has no compara-
tive series for non-hinged designs, but American data point to much lower rates. This may be because hinge prostheses are indi-
cated in more difficult cases, or because of problems of implant size — although authors using other hinged models have reported even lower infection rates: 3% for Lettin [15] and 1.7% for Bucholz [10].

Deep infection on hinge prostheses is unequivocally difficult to treat [6,11,13]. Our own results were poor. Our present attitude favors very early surgical revision, to have some chance of saving

<table>
<thead>
<tr>
<th>OA</th>
<th>Rheumatoid arthritis</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very good</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Good</td>
<td>33</td>
<td>13</td>
</tr>
<tr>
<td>Fair</td>
<td>21</td>
<td>5</td>
</tr>
<tr>
<td>Poor</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Non-assessable</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Patellar pain</th>
<th>Implant loosening</th>
<th>Reduced ROM</th>
<th>Difficulty walking and climbing stairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>6</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

Another solution is to implant another prosthesis, following resection that is as complete as possible, using cement mixed with antibiotics. This implies accepting the risk of failure, entailing further surgery. The attempt to conserve satisfactory knee function is not utopian: we reported successful cases in the French Revue de Chirurgie Orthopédique in 1977 [8].

Aseptic loosening is the only complication the rate of which increased over follow-up (16%). The rate of loosening was min-
imal in Amstutz’s series [5] (2.5%) and that of the Mayo Clinic [11] (4.9%), but those differences were probably due to insuffi-
cient follow-up. Insall [13] reported 27% loosening at over 2 years follow-up. Radiologic signs are often clearer in the tibia, and are to be distinguished from the simple radiolucency reported in all series, without functional impact [1], if, as is usually found, even at prolonged follow-up, it does not worsen.

Amstutz’s team have published a very detailed study of radiolu-
cency [5].

Rheumatoid arthritis, along with osteoporosis and varus posi-
tioning are certainly factors inducing or aggravating loosening. But it is perhaps the actual hinged design itself which is the main cause, greatly modifying the mechanical behavior of the knee [20]. Like Amstutz [5] and Insall [12], we were struck by the fact that fixa-
tion was often defective in wide diaphyseal-metaphyseal regions, and we consider this to be one of the main reasons for loos-
ening. We therefore agree with Amstutz that the fixation technique needs improving by injecting cement via a syringe to close the diaphyseal canal. We would further recommend frequent use of the second generation GUEPAR, which has an enlarged epiphy-
seal support with reinforced diaphyseal stems to enhance fixation in the medullary canal. The GUEPAR-2 is too recent for com-
parison of results with the present series: at 2 to 3 years follow-up so far, however, there have been no revision surgeries for aseptic loosening.

Revision for aseptic loosening almost always revealed grayish metal deposits in soft tissue and bone. This is due to wear of the hinge axis – less serious in new models, where surface adjustment and finish have been improved. These findings should be seen in relation to the frequency of voluminous liquid effusion found at revision, in 59% of knees according to Amstutz. Is wear debris implicated in metallosis, as in metal-metal total hip replacement? Does it cause loosening? If metallosis is responsible for loosening, why does loosening often concern a single tibial or femoral component,
as in 6 of our 10 cases of revision? However, even if debris is not the prime culprit in loosening, it certainly induces osseous deterioration with altered hinge axis. On trying out various materials, we obtained very satisfactory in vitro results for axial wear using polyethylene bearings. This finding is in agreement with Lettin’s clinical experience [15] with the Stanmore prosthesis, for which the aseptic loosening rate did not exceed 5%. The St-Georg hinge prosthesis [10] also has a hinge axis with a polyethylene bearing, and presents a loosening rate of 3.7%.

The three principal complications studied here were those mainly implicated in fair or poor results. Our experience is that functional results degrade very little over time, except in case of aseptic loosening. The modifications made to the prosthesis and the frequent use of GUEPAR-2 have considerably improved medium-term results.

As regards the role of hinge prostheses with respect to the generation of “semi-constrained” models, without intra-diaphyseal stem, the GUEPAR prosthesis has certain advantages: it can be implanted easily and quickly by non-hyperspecialized surgeons, with very little risk of error; functional recovery is quick and the knee, which is immediately stable and pain-free, easily recovers motion in flexion without extension deficit, which is especially important in case of multiple joint involvement; and functional gain is maintained over time (Fig. 5). Etiology seems to be an important factor in the choice of arthroplasty: the GUEPAR prosthesis is indicated in neurogenic arthropathy, as confirmed by the Mayo Clinic data [11]. In our opinion, however, a model equivalent to GUEPAR-2 should be used, to ensure good diaphyseal fixation. In rheumatoid arthritis in the over-1960s, we also prefer GUEPAR in severely osteoporotic forms, especially when there is marked deformity with severe flexion contracture and in rare cases of severe instability with recurvatum. In osteoarthritis, semi-constrained prostheses are adapted to almost all situations. Even so, there remain, in our opinion, indications for hinge prosthesis in very elderly patients (> 75 years) with bilateral involvement, in case of severe bone loss or anatomic configuration severely disturbed by previous osteotomy. Another indication for GUEPAR is revision surgery in case of previous arthroplasty. Indications are difficult to systematize, depending on the anatomic lesions and risk of infection.

Conclusions

The present series of 183 knees operated on using the GUEPAR hinged prosthesis before January 1st, 1974 shows that the complications threatening outcome generally appear quite early on. The present follow-up, of between 5 and 8 years in 101 cases, found no functional deterioration over time except in aseptic loosening, where the overall revision rate was 6%.

Surgical technique and implant design have evolved since the present study period. We now recommend a vertical medial cutaneous approach penetrating the joint space between the rectus femoris and vastus medialis, with possible sectioning of the lateral retinaculum, systematic use of a patellar implant, and fixation with closure of the diaphyseal canal and cement injection.

The main modifications made to the design are: hinge axis fixation by clips; non-grooved diaphyseal stem; and model 2, with wider and longer diaphyseal stems for improved fixation to shafts that are often enlarged in elderly subjects. In model 2, the increased trochlear groove depth enhances lateral stabilization of the patella (Fig. 6). The hope is that, with the polyethylene bearings on the hinge axis, problems of wear will be minimized.

All these modifications reduce the risk of complications and make the prosthesis more reliable, rapidly achieving good and lasting functional results. Infection, however, is a serious risk and this prosthesis should not be used when it is foreseeable.

Given the good results associated with semi-constrained designs, we currently use the GUEPAR prosthesis only in severely osteoporotic elderly patients with severe deformity and frequent multiple joint involvement, in rare cases of neurogenic arthropathy, and in certain revision surgeries following non-hinged prosthesis arthroplasty.

Disclosure of interest

Authors’ disclosure of conflict of interest was not requested when the article was originally published.

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