Total knee replacement in post-traumatic arthritic knees with limitation of flexion

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KEYWORDS
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Summary The objective of this study is to investigate the results of total knee arthroplasty (TKA) in traumatic osteoarthritis cases with flexion restriction and to describe the technical details of their management. A multicentre series comprising 40 patients with limitation of flexion less than or equal to 90° was selected from 152 cases of post-traumatic knee arthritis with malunion. We hypothesized that the arthroplasty complication rate would be higher than in other etiologies of limitation of flexion and would require specific management strategies.

Patients: In 23 cases, intra-articular malunion was present, in 15 cases extra-articular, and in two cases combined. The mean flexion was 72±23°, extension was 6±6°, and total range of motion (ROM) 66±23°. Eight cases of flexion restriction were severe (flexion < 50°), six intermediate (flexion, 50—70°) and 26 moderate. In 14 cases, the anterior tibial tuberosity was osteotomized (43% intra-articular malunion and 6% extra-articular malunion). Five simultaneous realignment osteotomies were necessary. In severe cases of limitation of flexion, five extensive quadriceps releases were associated.

Results: Four mobilizations under general anesthesia were performed. In the cases of severe limitation of flexion, we noted three avulsions of the patellar tendon, two cases of cutaneous necrosis, one of which was associated with deep infection, and another case of deep infection. In the cases of moderate limitation of flexion, we noted one case of nonunion of the tibial...
TKA in post-traumatic limitation of flexion

Introduction

Although many articles have reported on total knee arthroplasty for the stiff knee, to our knowledge there has been no study specifically treating replacement of stiff knee joints with post-traumatic gonarthrosis (gonarthrosis with malunion). However, antecedents of trauma (previous intra-articular operations, multiple scars, frequent past infectious episodes) are recognized as factors of stiffness. In another series, Massin et al. [1] reported 42% post-traumatic etiologies in a series of 128 knees with limitation of flexion, 36% of which were combined limitations (limitations of flexion and extension). We felt it necessary to study the results of arthroplasties on stiff knees in this specific etiology so as to describe the complications and determine whether the results depend on the type of nosology (intra- or extra-articular malunion).

To answer these questions, we present the results of 40 arthroplasties for post-traumatic gonarthrosis with limitation of flexion, with a mean follow-up of 5 years. This group of patients comes from a multicentre study of 152 total knee arthroplasties for gonarthrosis with intra- or extra-articular malunion of the tibia and/or the femur, collected retrospectively in eight centers specialized in this type of surgery for the French Hip and Knee Society (Société française de la hanche et du genou) symposium on post-traumatic gonarthrosis (Paris, 2009). The 40 cases of limitation of flexion, which appeared as a frequent sequela in this series of post-traumatic gonarthrosis (26%), were selected for the flexion amplitude of their knee, which did not exceed 90°, with three cases associated with severe flexion contracture greater than 20°.

The working hypothesis was that, despite a high complication rate, knee arthroplasty is still warranted because it contributes a benefit, including in terms of mobility in this type of stiffness, but that specific management is required to reach these results.

Patients and methods

Patients

Forty patients with post-traumatic limitation of flexion had a total knee arthroplasty (TKA) between September 1990 and September 2008. In 23 cases, malunion was intra-articular (31% of the intra-articular malunion cases in the symposium series), in 15 cases extra-articular (19% of the extra-articular malunion cases in the symposium series), and in two cases combined (Table 1).

Intra-articular malunion involved the tibial plateaux (16 cases), the femoral condyles (six cases), or the patella (one case). The extra-articular malunions affected the diaphysis and/or the inferior femoral metaphysis (11 cases) and the tibial diaphysis (four cases). Finally, two femoral malunions were metaphyseal-epiphysseal.

Except for a fracture treated with traction, the other femoral fractures, including six open fractures, were initially treated with osteosynthesis (two external fixators, two plate and six intramedullary nail osteosyntheses). The tibial plateaux were fixed in open surgery with plates and screws. The tibial diaphysis fractures had initially been nailed. In 13 cases, the initial osteosynthesis was complicated by infection, including eight dating back more than 2 years. In all, six knees had no scars, with the osteosynthesis on the diaphyses, whereas 14 had one scar and 19 knees had two or more scars. Logically, the proportion of knees without scars was greater in the cases of extra-articular malunion (three cases, 21%) compared to the cases of intra-articular malunion (three cases, 13%). On the other hand, the proportion of knees with several scars was higher for extra-articular malunion (eight cases, 57%, versus 11 cases, 48%, for intra-articular nonunion), which can be explained by the extension of the scars resulting from para-articular metaphyseal osteosynthesis or those resulting from the use of tibial nails.

Malunion induced frontal deformity in 37 cases: 28 varus deviations (170 ± 6°; range, 158–179°) and nine valgus deformities (194 ± 10°; range, 182–210°). Five rotational deformities were found. Two patients had already undergone treatment for their knee stiffness, one with arthroscopic arthrolysis and the other with quadriiceps release according to Judet et al. [2]. At the time of the arthroplasty procedure, the mean preoperative flexion was 72 ± 23° (range, 10–90°) and the mean preoperative exten-

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Demographic data of the general population.</th>
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<tbody>
<tr>
<td>Age</td>
<td>59 ± 15 (20–82)</td>
</tr>
<tr>
<td>Sex-ratio (F/H)</td>
<td>0.90</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>0.26 ± 0.04 (0.2–0.35)</td>
</tr>
<tr>
<td>Preoperative flexion</td>
<td>79 ± 26° (10–90°)</td>
</tr>
<tr>
<td>Preoperative extension</td>
<td>4.5 ± 4.9° (0–15°)</td>
</tr>
</tbody>
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sion was $6 \pm 6^\circ$ (range, $0^\circ$–$20^\circ$), with mean joint range of motion $66 \pm 23^\circ$ (range, $10^\circ$–$90^\circ$). Three patients had combined limitation because the flexion deficit was associated with a $20^\circ$ extension lag, with $60^\circ$, $20^\circ$, and $60^\circ$ range of motion. In 16 cases ($40\%$), the patella was considered low because the Caton and Deschamps Index [3] was less than 0.8, which, curiously, affected most particularly the cases of extra-articular malunion ($0.5 \pm 0.1$ versus $1.1 \pm 0.7$ for the cases of joint malunion).

In terms of severity, eight cases of limitation of flexion were considered severe ($20\%$) because the maximum flexion was less than or equal to $50^\circ$, six were considered mediocre (preoperative flexion between $50^\circ$ and $70^\circ$ [15%]), and 26 moderate (preoperative flexion between $70^\circ$ and $90^\circ$ [65%]) (Table 2).

### Surgical technique

All patients received a total knee replacement because of the overall condition of the knee, the advanced stage of impairment, or osteoarthritic pain. All implants were posterior-stabilized. A lateral approach was used in ten cases and a medial approach in 30, with eight subvastus approaches. In 14 cases (35%), anterior tibial tuberosity osteotomy was required to reach the knee, in ten cases for intra-articular malunion (43%) and in four cases for extra-articular malunion (26%). Realignment osteotomies had to be associated with the prosthesis in five cases: a proximal tibial metaphyseal osteotomy of a metaphyseal-epiphyseal malunion, three metaphyseal osteotomies for femoral, tibial, and combined (femoral and tibial) diaphyseal malunions, and one distal tibial derotation osteotomy. The osteotomies were performed via the same approach as used for the arthroplasty except for the tibial derotation osteotomy, which required a specific approach.

In the cases of mediocre and moderate limitation of flexion, the associated procedures essentially involved ligaments: six lateral retinaculum releases and three collateral ligament releases (two medial and one lateral). In one case of limitation of flexion, the operator indicated that he had increased the tibial slope to open the joint space in flexion. In one of two cases of combined limitation, the tibial cut was increased to open the two-flexion and extension joint spaces. Finally, in the most severe cases of limitation of flexion, five complete quadriceps releases according to Judet et al. [2] were associated with arthroplasty.

### Assessment methods

The clinical scores of this retrospective multicentre study were established using a simplified scale [1] of the International Knee Society (IKS) [4]. The function score was based on two parameters, each rated out of 50 points (walking test and ascending and descending stairs), with 20 points subtracted when walking aids were used (canes or crutches). A score of 90 or higher reflected a very good result, a score of 70–89 a good result, a score of 60–69 a mediocre result. Lower scores were considered to reflect a poor result. Pain was evaluated separately out of 50 points. Radiographic follow-up was based on antero-posterior (AP) and lateral x-rays of the knee as well as on femoropatellar skyline views. Any radiolucent lines at the cement–bone interface in all zones defined by the IKS were noted [5].

The Student $t$-test for small samples was used to compare the quantitative values of the two patient groups, with a significance threshold defined at 0.05. The Spearman correlation coefficient was used to compare pre- and postoperative mobility.

### Results

The patients were reviewed with a mean follow-up of $5 \pm 4$ years (range, $0^\circ$–$15$ years), 11 were lost to follow-up, including one at 3 months of follow-up, and the others at more than 1 year, with six at more than 5 years of follow-up. In all, 39 patients were seen again with more than 1 year of follow-up (23 with less than 5 years and 16 with more than 5 years of follow-up [range, $5^\circ$–$18$ years]).

### Table 2  Stiffness groups versus level of severity.

<table>
<thead>
<tr>
<th></th>
<th>$\leq 50^\circ$</th>
<th>$[50^\circ$–$70^\circ]$</th>
<th>$[70^\circ$–$90^\circ]$</th>
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<tbody>
<tr>
<td>$n$</td>
<td>8</td>
<td>6</td>
<td>26</td>
</tr>
<tr>
<td>Preoperative flexion</td>
<td>$31 \pm 13^\circ$</td>
<td>$65 \pm 5^\circ$</td>
<td>$86 \pm 5^\circ$</td>
</tr>
<tr>
<td>Age</td>
<td>$50 \pm 14$ ans</td>
<td>$59 \pm 12$ ans</td>
<td>$62 \pm 16$ ans</td>
</tr>
<tr>
<td>Number of previous operations</td>
<td>$2,5 \pm 2$ (4 $\geq 3$)</td>
<td>$2,8 \pm 1,8$ (3 $\geq 3$)</td>
<td>$1,8 \pm 1,4$ (7 $\geq 3$)</td>
</tr>
<tr>
<td>Septic antecedents</td>
<td>4 (50%)</td>
<td>2 (33%)</td>
<td>6 (23%)</td>
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### Table 3  Complications versus severity of preoperative stiffness.

<table>
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<tr>
<th>Severe stiffness ($n = 8$)</th>
<th>Moderate stiffness ($n = 26$)</th>
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<tr>
<td>Six complications (75%)</td>
<td>Five complications (19%)</td>
</tr>
<tr>
<td>Three avulsions of the patellar tendon</td>
<td>One popliteal artery injury</td>
</tr>
<tr>
<td>Two cutaneous necroses (with one followed by infection)</td>
<td>One intraoperative tibial fracture</td>
</tr>
<tr>
<td>One revision of implants for deep infection</td>
<td>One pseudarthrosis of the anterior tibial tuberosity</td>
</tr>
<tr>
<td></td>
<td>Two implant revisions (one deep infection, one aseptic loosening)</td>
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</table>
Eleven complications occurred in the first year of follow-up (25% of the cases). Six of them involved the group with severe limitation of flexion (Table 3). Three avulsions of the patellar tendon occurred. Direct sutures were applied with finally residual 20, 10, and 20° extension lag. Two cases of cutaneous necrosis occurred, with one leading to early infection successfully treated with lavage and antibiotic therapy with no change in the implant. Finally, another infection occurred, requiring removal of the prosthesis. Three of these complications (the two infections and one avulsion of the patellar tendon) were found in the group of five patients who had undergone quadriceps release.

In the cases of moderate limitation of flexion, a vascular lesion occurred during tibial cerclage performed to fix an enlarged osteotomy of the anterior tibial tuberosity, repaired with bridging, with no further complications. An intraoperative fracture occurred during insertion of a stemmed tray in a knee that had been operated on several times: simple screw fixation provided union with no migration of the tibial component. Nonunion of the anterior tibial tuberosity was revised with avivement and screw fixation 6 months after arthroplasty. Finally, two early implant revisions at 1 year were necessary, one for deep infection, the other for aseptic loosening.

Over the entire series, the pain score increased from 6 ± 7 preoperatively to 39 ± 16 at the last follow-up (mean gain, 33 points). The preoperative function score increased from 36 ± 25 to 80 ± 24 at the last follow-up (mean gain, 44 points). Whereas there were 31 patients with poor preoperative function, there were eight at the last follow-up; six of these patients had a walking test result under 10 minutes. The mean flexion at the last follow-up was 99.4 ± 23° (mean flexion gain, 26.7 ± 20°) (Fig. 1). Flexion at the last follow-up was significantly correlated with preoperative flexion ($r = 0.62; P < 0.01$). The gain in flexion was negatively correlated with preoperative flexion ($r = -0.47; P < 0.01$). The final range of motion was $99 ± 27°$ for a mean gain of $33 ± 21°$, positive in 38 patients. Two patients with 90° preoperative flexion lost five and ten degrees at the last follow-up, but this did not affect their functional result. Four mobilizations were performed under general anesthesia, resulting in 60, 90, and 100° final flexion, and the last with combined limitation, whose insert was also changed for a thinner one, giving $110°$ final flexion.

There was no difference between the increases in flexion of the intra-articular and extra-articular malunions ($P = 0.21$). The associated procedures, whether osteotomy of the tibial tuberosity for better exposure or corrective osteotomy associated with malunion, did not influence the gain in flexion ($P = 0.48$ and 0.18, respectively). However, Judet quadriceps release had a positive influence on the gain in flexion ($50.4 ± 30°$ versus $22.8 ± 16°$ without release; $P = 0.001$).

Other than one case of revised early loosening, the radiological aspect of the bone–cement interface was satisfactory. Limited radiolucent lines developed in three cases, but were stable at 6, 7, and 8 years of follow-up.

**Discussion**

Total knee arthroplasty provides substantial gains in flexion in these stiff knees, in addition to the significant improvement in pain and overall knee function. The gains in flexion, a mean 20°, appear even more considerable given that preoperative flexion was limited, even if the final flexion remains dependent on the severity of the preoperative stiffness. On the other hand, patients with moderate stiffness, i.e., flexion close to 90° before the intervention, risk losing a few degrees of flexion, as occurred in two of the patients in this series.

In the cases of intra-articular malunion, the surgical strategy is relatively unequivocal. In cases of operated articular fracture sequelae, it is preferable to work with one of the existing scars, preferring one located in the frontal deformity concavity. Osteotomy of the anterior tibial tuberosity has broad indications with no major risk of compromising recuperation of flexion range of motion. In the overall series, six osteotomies of the anterior tibial tuberosity were programmed in principle because of the severity of the stiffness (preoperative flexion less than 50°), but eight were decided during the operation in cases of moderate stiffness with a low patella to improve exposure without causing excessive traction on the extensor apparatus. In
In the extra-articular malunions, priority should be given to realigning the knee. Our results show that both diaphyseal and metaphyseal osteotomies do not reduce the gain in flexion. The highest gains, sought in the most severe cases of stiffness, were only possible at the cost of complete release of the extensor apparatus as described by Judet et al. [2]. This procedure, performed in four out of five cases in the series in extra-articular malunion, can be associated with arthroplasty when it is isolated. However, even if this occurred in one of the patients in the series, it seems risky to associate it with an extra-articular femoral osteotomy, because the stresses applied during rehabilitation of the osteotomy site can compromise bone union.

These results, in terms of flexion gain, remain comparable to those obtained in series of more heterogeneous etiologies on stiff knees, like complications occurring particularly in the most severe cases of stiffness [1–6]. Bae et al. [7] report final range of motion at 98° in a series of very stiff but not ankylosed knees, close to the values in our series. Bhan et al. [8] report a 35° gain in range of motion with arthroplasty performed on very stiff knees, also corresponding to our results. The highest complication rates are found in patients with traumatic sequelae and are naturally concentrated on severe cases of stiffness, which had the highest number of surgical, notably infectious, antecedents, and therefore, the poorest cutaneous conditions (multiple scars). Among the most serious complications are avulsion of the patellar tendon, which should be feared whenever preoperative flexion does not exceed 80°, notably in cases of low patella. This results in exposure problems. Recourse to osteotomy of the tibial tuberosity does not eliminate the risk since two of the three avulsions occurred postoperatively in knees treated with osteotomy of the tibial tuberosity. Rehabilitation in flexion can therefore cause postoperative rupture, notably when some factors of joint stiffness persist. Although this was not the case in our series, mobilization under general anesthesia can promote this complication and should be done cautiously. When avulsion of the patellar tendon occurs, several types of repair are possible depending on the tendon's condition: either direct repair protected by patellotibial cerclage or autologous [9] or heterologous [10–11] reconstruction. In all cases, the durability of the repair should be tested so as to allow passive rehabilitation of flexion in the least restrained area possible and to prevent complete recurrence of the stiffness. However, the price to pay has been persistence of extension lag in our three cases of direct suturing. Quadriceps release, when decided, does not protect from avulsion of the patellar tendon (one case out of five releases in our series). Even without this complication, this technique can weaken the extensor apparatus and generate extension lag, as has been reported by Bellemans et al. in a context of Judet quadricepsplasty [12] with no joint replacement.

Cutaneous necrosis is the second damaging complication because it can expose the implant material and thereby generate infection (one case of necrosis out of two in this series). When a scar from previous osteosynthesis is already present, it should be reused for the next approach. When there are several scars, notably from previous procedures, high-flexion ischaemia generated by cutaneous distension may occur. In these conditions, it is certainly more prudent to abandon the idea of obtaining high-flexion range of motion, i.e., beyond 90°. In particular, it seems difficult to envisage quadriceps release, which, by favoring high flexions, increases the distension of the previously scarred skin.

It is therefore important to discuss a contract with the patient before surgery: knee arthroplasty could provide a few additional degrees of flexion, but in patients with multiple cutaneous scars it may be preferable to avoid aiming toward greater mobilization. Arthroplasty should therefore be preferred for its pain-removal effect. In cases of gonarthrosis combined with intra-articular malunion, attention should be focused on exposure of the knee with wide use of anterior tibial osteotomy to treat the articular factors of knee stiffness. In cases of extra-articular malunion, priority should be given to correcting extra-articular deformities, if need be by associating osteotomy with the prosthesis. When substantial range of motion is sought for functional reasons in young patients for example, only complete release of the quadriceps can provide substantial gain in flexion, but this can only be envisaged in patients aware of the risks involved, provided the patient’s cutaneous condition is good with at most one scar from previous surgery as well as no recent history of infection. Reasonably speaking, this is only possible in cases of isolated arthroplasty without associated osteotomy.

**Conflict of interest statement**

G.D.: financial interest in Tornier International.
P.M.: auditor for Tornier International.
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V.G.: no conflict of interest.

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References