Total knee replacement in the fixed valgus deformity using a lateral approach: role of the automatic iliotibial band release for a successful balancing

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Abstract The purpose of this work was to document eleven years of experience in knee replacement for fixed knee valgus through a lateral approach with special emphasis on the balancing procedures. At a mean follow-up of seven years, only one revision for sepsis was required in this series of 63 knee replacements. The mean knee score improved from 37 (range 20–45) to 91 (range 65–100) at the last review ($p<0.01$) while the function score increased from 29.5 (range 0–50) to 78.7 (range 10–100) ($p=0.01$). The mean mechanical axis (HKA) was 14.7° of valgus preoperatively and 1° of valgus postoperatively. After the iliotibial band was automatically released in the approach, only four of 63 knees required additional release for tightness in extension. These results underline the appeal of the lateral approach with the automatic release of the iliotibial band. If required, additional ligament release is recommended step-by-step after bone section to avoid postoperative instability.

Résumé Le but de cette étude était de rapporter onze années d'expérience de la voie d'abord latérale du genou pour implantation d'une prothèse totale pour genu valgum fixé. Une attention particulière a été portée sur les techniques d'équilibrage ligamentaire. Au recul moyen de 7 ans, une seule reprise chirurgicale dans notre série de 63 prothèses avait été nécessaire en raison d'une infection. Le score moyen du genou était de 37 (20 à 45) en post-opératoire et de 91 (65 à 100) au dernier recul ($p<0.01$) alors que le score fonctionnel passait de 29.5 (0 à 50) à 78.7

(10 à 100) ($p=0.01$). L'axe mécanique HKA était de 14.7° de valgus en préopératoire et de 1° de valgus en post-opératoire. Après libération de la bandelette ilio-tibiale, seulement 4 sur 63 des genoux nécessitaient des gestes de libérations supplémentaires pour raideur en extension.

Introduction

The goals of a total knee replacement for a fixed valgus deformity are similar to those of the varus knee, i.e. the creation of balanced extension and flexion gaps and restoration of the proper mechanical alignment of the lower limb. Nevertheless, the technique is still a matter for discussion whether it requires the medial or lateral approach and which structures should be released to correct a fixed deformity.

Some surgeons use only the medial approach [4, 15, 19, 20] but this, located on the opposite of the retracted structures, often necessitates the release of the patella lateral retinaculum with a consequential risk of devascularisation [9]. Klebisch [10] proposed a lateral approach, which has none of these disadvantages but requires the mastering of a new technique. Moreover, its use is limited by an increased risk of proximal patella migration due to release of the patellar tendon insertion [2, 10].

In order to correct the valgus deformity, different techniques have been proposed to relax the tight structures [1, 4, 17, 20]. The lateral collateral ligament and the popliteus tendon, tight in flexion, can be released subperiosteally at the lateral condyle using a lateral femoral sliding osteotomy or sectioning them at the level of their insertion [1, 20]. The so-called pie crusting technique [4, 17] relaxes the posterolateral structures and can also be applied to the iliotibial band (ITB) tight in extension. Others have used a Z, V–Y shaped incision or a transverse cut above the articulation [10, 15]. The lateral approach we

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use also allows the automatic ITB division and elevation from the Gerdy's tubercle to be taken in continuity with the anterior compartment fascia, and release of the attachments of the lateral part of the femur [2, 12].

With the insight of 11 years of experience, the objective of our work was to evaluate the clinical and radiological outcomes of knee replacements performed for the fixed valgus deformity through a lateral approach. We also present a description of the technique we used with emphasis on the balancing procedure.

Materials and methods

We retrospectively reviewed 66 patients (66 knees) undergoing total knee replacements (TKR) for fixed valgus deformity from January 1995 to December 2004. Data were obtained from our prospectively collected database on 700 patients who had a TKR since January 1995 in our department.

Inclusion criteria for the study were patients with primary total knee replacement and preoperative fixed knee valgus deformity of more than 10 degrees, performed through a lateral approach, with a clinical follow-up of at least four years.

Two patients with bilateral replacements were excluded in order to avoid the problem of repeat measures in the statistics analysis. One patient was lost to follow-up two years after the implantation and was excluded. Thus, 63 patients (63 knees) were eligible for this study.

There were 56 women and seven men ranging in age from 26 to 81 years (mean 65.9 years) at the time of implantation. Mean height was 1.61 m (range 1.49–1.85), and mean weight was 66.9 kg (range 40–105). The diagnoses were osteoarthritis in 43 patients and rheumatoid arthritis in 20 patients. All TKR were performed by one surgeon (Denis Hutten) and assessed at standard intervals until the last outpatient visit.

Prostheses

In this series, the Wallaby total knee system (Centerpulse-Zimmer, Warsaw, Indiana, USA) was implanted. The Guepar Group, together with Protek engineers (Centerpulse-Zimmer, Warsaw, Indiana, USA), developed this prosthesis which is available with a post and cam mechanism (postero-stabilized Wallaby II) and an ultracongruent tibial insert (Wallaby I with UC insert). In this series, the posterior cruciate ligament was sacrificed in every case and a post and cam mechanism was implanted (postero-stabilized Wallaby II). The patella was resurfaced using a cemented inlay dome implant of 30 mm for postero-stabilized. All components in all knees were cemented in place.

Operative technique

All of the patients were operated in a supine position using a tourniquet that was released before closure after implantation of the prostheses.

A lateral parapatellar incision centred on the bottom of Gerdy's tubercle was used. The deep incision was extended in the tendon of rectus femoris (RF) 2–3 mm from the edge of the vastus lateralis (VL), then followed the lateral edge within 1 cm of the patella, going towards Gerdy's tubercle and extending on to the anterior compartment fascia (Fig. 1). The lateral parapatellar arthrotomy was started at the proximally and continued until it reached the superior pole of the patella, and from there the synovial tissue was removed at the edge of the patella to its distal limit. At this stage, the fat pad was divided from the patellar ligament and mobilised posteriorly with the lateral meniscus on a vascular lateral hinge. Care was taken during the lateral arthrotomy to preserve these structures, primarily the meniscal attachments that vascularise the fat pad (Fig. 1).

The posterior flap resulting from the division of the iliotibial band and fibrous attachments were released from the lateral part of the distal femur, the condyle up to the posterolateral corner, and subperiosteally from Gerdy's tubercle in continuity with anterior compartment fascia (Fig. 1). The anterior flap was also detached from Gerdy's tubercle.

The patella was subluxed medially. If this proved difficult the incision between Vastus Lateralis and Rectus Femoris was extended proximally.

A 10 mm medial tibial resection was performed using an intramedullary guide with a posterior slope of 3°. A medial 9 mm thick femoral distal resection was performed with 3° or 5° of valgus, depending on preoperative radiographic measurements.

Fig. 1 Division and elevation from Gerdy's tubercle of the iliotibial band, taken in continuity with the anterior compartment fascia and dissection of the fat pad

A 10 mm thick spacer was inserted in extension in order to control the joint alignment and ligament balance. If it was not possible to introduce it in the lateral compartment, it was only introduced on the medial side and a varus stress. If the knee was always tight in extension after ITB release, additional releases were performed. A tight postero lateral capsule was detached from the posterior condyles and/or transected at the level of the tibial cut from PCL insertion to the posterolateral corner. If this was insufficient, release of the gastrocnemius and the biceps tendon could be considered. As soon as the spacer could be introduced, ligament release was stopped to prevent varus laxity. Ligament balancing was achieved when the knee was aligned in both the frontal and sagittal planes with a medial and lateral opening of 2–3 mm when forced valgus and varus stress were applied at 5° of flexion.

Femoral component rotation was then determined at 90° of flexion using a tensor with separated distraction of both compartments (and two lamina spreaders). The epicondylar axis and the Whiteside line were also determined as a control. The posterior cut was performed parallel to the tibia. The size of the femoral component was selected to obtain a 10 mm quadrangular flexion gap, without medial or lateral overhang. The spacer was introduced in this gap and the ligament tension checked.

If the knee was tight in flexion, the lateral collateral ligament (LCL) and/or popliteus tendon were released subperiosteally from the femur. If knees were tight both in flexion and extension, all structures causing the tightness were selectively released.

The tibial metal back was selected compatible with the femoral component and to provide full coverage of the tibial cut without any overhang. Tibial rotation was determined with femoral and tibial trial components articulated and the knee extended.

The lateral arthrotomy was closed from proximal to distal, with the knee slightly flexed until suture was no longer possible (Fig. 2a). From there, the fat pad accompanied with the lateral meniscus was used to finish the coverage of the joint. It was presented and spread out in such a way that it covered the prostheses. It was sutured to the iliotibial band posteriorly and to the capsule of the lateral border of the patella anteriorly (Fig. 2b). The knee was mobilised to assure that sutures were not compromised in the course of flexion extension.

Rehabilitation of the knee was undertaken immediately using a passive motion machine. Two crutches allowed by the second or third day relieved a full weight bearing.

Clinical assessment All patients had a preoperative and annual postoperative examination until the last outpatient visit. The Knee Society knee and function scoring systems were used for the clinical evaluation at each visit for a minimum of four years [7].

Fig. 2 **a** Closing of the iliotibial band (ITB) division with exposure of the joint at the bottom of the incision. **b** Total coverage of the joint using the fat pad flap

Radiographic assessment The authors analysed radiographs obtained before surgery and in postoperative periods at standard intervals until the last review. They included anteroposterior (AP) weight bearing radiographs, lateral radiographs, and skyline patellar radiographs. They assessed the position of the component as well as the presence and location of all radiolucent lines at the bone–cement interface according to the recommendations of the Knee Society [5]. The skyline patellar radiographs were examined for patellar tilt, subluxation, or dislocation. Osteolysis, radiolucent lines around the three components, and loosening were recorded. Both pre- and postoperative alignment of the limb were measured on standing full leg radiographs before surgery and one month after the operation.

Statistical analysis

Clinical and radiographic results were expressed as either means with ranges or percentages. Continuous data were tested for normal distribution using the Kolmogorov-Smirnov test. Normally distributed data were analysed with two tailed *t*-tests, whereas non-parametric data were analysed with the Mann-Whitney U test. Statistical significance was set at $p < 0.05$.

All statistical analyses were performed with SAS 9.1 software (SAS Institute, Cary, NC, USA).

Results

Follow-up

The mean follow-up was seven years, which ranged from four to 11 years.

Complications

In the immediate postoperative period, a nerve palsy of the lateral popliteal nerve which recovered spontaneously seven months later was noted. One deep phlebitis and one skin necrosis, which did not necessitate any surgical intervention were also seen.

A postero-stabilized prosthesis dislocated three years after implantation following a fall on stairs. After closed reduction, no reoccurrence was observed.

Revision

Two-stage reimplantation was performed as treatment for one periprosthetic infection with *Staphylococcus* following total knee arthroplasty at one year.

Clinical results

Postoperatively, all knees were improved compared to the preoperative period (Table 1). The mean Knee Society and mean function scores preoperatively were 37 (range 20–45) and 29.5 (range 0–50) and at the last review 91 (65–100) and 78.7 (10–100), respectively. Improvements were both significant (Table 1). The mean flexion improved from 113.6° (range 60–130) before surgery to 117.3° (range 80–130) after ($p=0.55$). Mean pain score was 0.8 (range 0–20) preoperatively and 46.9 (range 20–50) at the last review ($p<0.001$).

We compared the clinical results of patients with rheumatoid arthritis and patients with osteoarthritis, although the groups were of unequal size (43/20). During the preoperative period, there was no significant difference between the two groups regarding knee score ($p=0.28$), function score ($p=0.20$), mobility ($p=0.06$), pain ($p=0.39$), or valgus deformity ($p=0.17$). In the postoperative period, knee score and function score were higher in the rheumatoid arthritis group than in patients with primary osteoar-

Table 2 Radiographic results

Period	Mechanical axis	Subluxations	Tilts
Preoperative	14.7° of valgus	12 lateral	9 lateral
Postoperative	1° of varus	0	3 medial 2 lateral

thritis. However, differences did not reach statistical significance ($p=0.10$ and $p=0.54$, respectively).

The best range of motion was recorded in the osteoarthritis group with a mean flexion of 118.2° (range 90–130) compared to 115.4° in the rheumatoid arthritis group. However, the difference was not significant ($p=0.77$). Lastly, pain relief was significantly better in the rheumatoid group (49.3 versus 45.8; $p=0.03$).

Radiographic results

The mean preoperative femorotibial anatomical alignment, measured on weight-bearing AP radiographs, was 14.7° of valgus (range 10–27°). Postoperative weight-bearing AP radiographs of the knee confirmed the femorotibial alignment to be a mean angle of 1° of valgus (range from 3° of valgus to 5° of varus).

Preoperatively there were 12 subluxations of the patella and nine lateral tilts. At the last follow-up, there was no lateral subluxation and five lateral tilts (three medial and two laterals). Nonprogressive horizontal radiolucent lines (<2 mm) under the tibial component were present in seven knees. There were no cases of radiographic tibial, femoral, and patellar loosening or osteolysis (Table 2).

Ligamentous release required

The automatic release of the iliotibial band was the only release for 85% of the knees (54/63 cases).

In four cases (two knees in both the rheumatoid group and the primary osteoarthritis group), the knee was tight in extension. An additional release of a posterolateral capsule was sufficient to obtain a satisfactory balancing in extension.

In five other cases presenting the highest deformities, including three knees of the rheumatoid group and two of osteoarthritis group, the knee was tight in flexion due to retraction of the lateral collateral ligament and the popliteus

Table 1 Clinical results

Evaluation	Knee score	Flexion (range)	Function scores	Pain score (range)
Preoperative period	37 (20–45)	113° (60–130°)	29.5 (0–50)	0.8 (0–20)
Last review	91 (65–100)	117.2° (80–130°)	78.7 (10–100)	46.9 (20–50)
<i>p</i> values	$p<0.01$	$p=0.55$	$p=0.01$	$p<0.001$

tendon. These structures required additional release from the femoral condyle. These spaces were balanced in extension, not requiring any additional release of the iliotibial band. The posterolateral capsule in these cases was not retracted and thus was left intact.

Discussion

When the valgus is fixed, the lateral soft tissues are retracted and/or too short, requiring release to implant a prosthesis. Nevertheless, the surgical approach is still a matter for discussion including which and how lateral structures should be released.

The iliotibial band, the posterolateral capsule, the gastrocnemius tendon, and the biceps tendon are all tight in extension and loose in flexion. In the valgus knee, the iliotibial band is the most important of these structures. The ITB is the main source of the deformity and its contracture prevents correction of the deformity in extension. The lateral approach that we practice first involves automatic division and release from Gerdy's tubercle left in continuity with the anterior compartment fascia (Fig. 1). To be complete, this release has to be extended to the posterior part of the external tibial plateau and attachments of the ITB to the lateral part of the femur. Others, also using a lateral approach, have offered different techniques of lengthening in Z, V–Y or stab multiple incisions of the iliotibial band [2, 6, 10, 18]. Keblish [10] also proposed reducing the continuity of the iliotibial band by a transverse section. Each section is at risk of weakening this main varus stabiliser in extension [12]. For this reason, we prefer to preserve its continuity. In our experience, no other release was necessary in four of 63 of the cases after division and elevation of ITB. We found that an additional posterolateral capsule, gastrocnemius tendon release may be necessary to correct the knee in extension.

Other releases may be mandatory on tight knees in flexion. In five cases, we performed femoral subperiosteal release of the collateral lateral ligament and the popliteus tendon. Other techniques were proposed such as section close to their bony insertion or sliding osteotomy of the lateral femoral condyle [1, 6, 20]. Some advocate that the popliteus tendon should be retained because of its function as an external stabiliser of the knee in flexion [12, 17]. Release of the popliteus tendon risks major laxity in flexion, although there was no such case in our series. Buechel [2] proposed a three step release technique of the lateral structures according to the severity of the valgus. Whatever the technique, we recommend performing ligament balancing after bone cuts step-by-step, to prevent postoperative lateral instability. Indeed, soft tissue release before any bone cut led to very serious postoperative

Table 3 Review of the literature for total knee arthroplasty implanted in fixed valgus knee

Series	Type of approach	Number of knees	Type of prosthesis	Average follow-up (y)	Knee score (pre/post)	Function score (pre/post)	Mobility in degrees	Alignment pre/post in degrees	Complications
Clarke et al. [4]	Medial	24	PS	4.5	-97	-74		15/5 valgus	24% postoperative instability;
Miyasaka et al. [15]	Medial	60	PS	10.7	28/88.7	30.2/69.2		16.8/4.5 varus	3 sepsis; 2 loosening
Fiddian et al. [6]	Lateral	27	PCL retaining	1	34/95	35/61	-117	17/ 6 valgus	1 cellulitis
Ranawat et al. [17]	Medial	42	PS	5	30/93	34/81	110/110	15/5 varus	1 revision for sepsis;
Keblish [10]	Lateral	53	MB	3	94.3% of good/excellent results according to NJOH score				1 revision for polyethylene wear; 1 revision for loosening
								22/-	1 skin necrosis
Lootwoet et al. [12]	Lateral	64	PS PCL retaining	2.5	60.2/93.6	35.9/73.2		16/1.5 valgus	6 skin necrosis; 4 sepsis;
This series	Lateral	63	PS	7	37/91	29.5/78.7	113/117.2	14.7/1 of valgus	1 nerve palsy
									1 skin necrosis;
									1 revision for sepsis; 1 nerve palsy; 1 traumatic dislocation

MB mobile bearing, PS posteros stabilized, PC retaining, posterior cruciate ligament retaining; NJOH score New Jersey Orthopaedic Hospital scoring scale

instabilities with levels reaching up to 24% in Miayasaki's series [15]. In our procedure, priority was given to thoroughly balancing the extension gap. In those cases, in which some laxity of the flexion gap persisted, a semiconstrained postero-stabilised implant should be used. The laxity should not exceed the vertical jumping distance of the post cam (i.e. 1 cm average). In the event of major laxity, we would use a more constrained implant or hinge prosthesis as a last resort. Last, we noted that additional releases (five in the rheumatoid group and four in the arthritic group) were required most of the time in greater deformities. However, due the small number of cases, it was not possible to statistically confirm whether the aetiology could influence the need for additional releases after ITB release.

The lateral approach has the main advantage of furnishing direct access to the tight structures. It also allows the preservation of medial soft tissue structures, primarily the medial retinaculum, along with vascularisation of the medial genicular blood supply [9, 16]. It also promotes the patellar tracking. There was no postoperative lateral patellar subluxation or lateral tilt of the patella in our series. The correction of a lateral rotation of the tibia also contributes to patellar alignment. Additionally, it facilitates an eventual neurolysis of the lateral popliteal nerve. Literature quotes 0.5–4% of cases result in paralysis [10, 11, 19]. Like others, we experienced one nerve palsy that recovered spontaneously [10, 12].

Literature has shown that (Table 3) skin necrosis or delayed healing remain frequent after the correction of valgus deformity using such an approach. This enhances the use of a meniscal-capsular-fat pad coverage that offers effective protection of the joint and avoids skin problems and subsequent joint infection (Fig. 2a and b). We do not recommend the Fiddian technique, which only proposes skin closure to cover the joint [6]. We prefer a posterior pedicle-based flap which is more logical than the one pedicle in the front [2] because the infero-medial geniculate artery is thinner than the lateral inferior geniculate artery [2]. Coronal Z lengthening of the ITB to close the arthrotomy has also been proposed with satisfactory results [18].

However, this approach can be criticised. The medial subluxation of the patella may be difficult, especially in the case of stiffness or a low patella. In this case, an osteotomy of the tibial tubercle should be performed. Some surgeons recommend a routine osteotomy [3, 14]. However, specific complications such as skin necrosis or non-union were reported [14, 21]. Subperiosteal release of the patellar tendon can lead to proximal patella migration, and for this reason it was abandoned [10]. Another controversy concerns the difficulty in exposing the postero-medial part of the tibial plateau. Keblish has proposed a limited posterior medial condyle resection to facilitate it [10]. The lateral

approach is also criticised for the difficulty of rotational tibial positioning explained through the inverse approach to the more usual medial approach.

Whatever approach used, the results of the knee score, function, and X-rays analysis seemed to show few differences between the series using a postero-stabilised prosthesis (Table 3). Nevertheless, a longer follow-up was mandatory to confirm the absence of difference in the complications. The lateral approach combined with division and elevation of the ITB did not show any difference in results regarding aetiology except the postoperative pain improvement that was significantly better in the rheumatoid group. Lastly, these results confirmed that a favourable and reliable long-term outcome may be achieved with total knee replacements in patients with rheumatoid arthritis [8, 13].

In conclusion, best known by surgeons, the medial approach can be used with results confirmed through hindsight. It is indicated in cases of reducible genu valgum in extension, whatever the importance of the valgus. In fixed deformities, the lateral approach seems more logical to us for the reasons we have demonstrated. Automatic division and elevation of the iliotibial band from Gerdy's tubercle achieve mobile and stable knees in the large majority of cases without any additional release in tight knees in extension. With experience, these technical difficulties are overcome and a satisfying function and alignment can be regularly obtained.

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