TITLE : Posterior Cruciate Ligament Substituting Total Knee Arthroplasty : Considerations in the Middle East

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1 author:

Samih Tarabichi
Al Zahra Private Hospital

Posterior Cruciate Ligament Substituting Total Knee Arthroplasty

Considerations in the Middle East

Sam Tarabichi
Majd Tarabichi

Introduction

The goals of total knee arthroplasty (TKA) have always remained the same as pertains to restoring the native anatomy, relieving pain, and bringing patients back to an earlier level of functioning. However, different populations with variations in anatomy, physiology, and functional needs necessitate a different approach. These characteristics must be taken into account when performing TKA in Middle Eastern patients, and can be divided into systemic features, local anatomic features, severity of disease, and activities of daily living. We should stress that Asian and Middle Eastern patients are very similar because of culture and lifestyle, as well as anatomic features. We found that the features that we reported in our scientific exhibit at the American academy of orthopaedic surgeons 2012 annual meeting were endorsed by our Asian colleagues' literature.[27,47] We will also describe perioperative management of Middle Eastern patients. Our approach is based on the authors' experience of practicing both in the United States and the Middle East, as well as data from our registry of more than 8000 total knee replacements (TKRs). We will focus on our results with the posterior stabilized prosthesis because the demands of the Middle Eastern knee are better served by a posterior stabilized implant, and this is for multiple reasons. First of all, the activities of patients in the Middle East involve a great deal of kneeling. Komistek et al. demonstrated in a kinematic study that posterior stabilized knees exhibited greater roll-back of the femur on the tibia,[26] which plays a crucial role in facilitating high flexion in the knee. In contrast, the cruciate-retaining knee implants showed a "paradoxical movement" whereby the tibia rolls forward on the femur in high flexion. The femoral roll-back mechanism increases the leverage of the patellar tendon, allowing the patient to place greater forces on the patellar tendon and thus enabling him or her to tolerate more of the activities of daily living (Fig. 141.1). This principle was the driving force behind John Insall's design of the NexGen LPS Flex (Zimmer Biomet, Warsaw, Indiana) knee prosthesis designed to accommodate greater flexion at the knee because he believed that posterior stabilized prostheses would provide more physiologic roll-back and accommodate deeper flexion. Furthermore, flexion-varus deformity, which is extremely common in the Middle East, results in a contracted posterior cruciate ligament (PCL), and thus PCL resection is needed, especially with flexion deformity of greater than 20 degrees. A contracted PCL is dysfunctional, and this is observable intraoperatively with subluxation of the tibia despite an intact PCL. This is the rationale behind our extensive use of posterior stabilized prostheses in Middle Eastern patients.

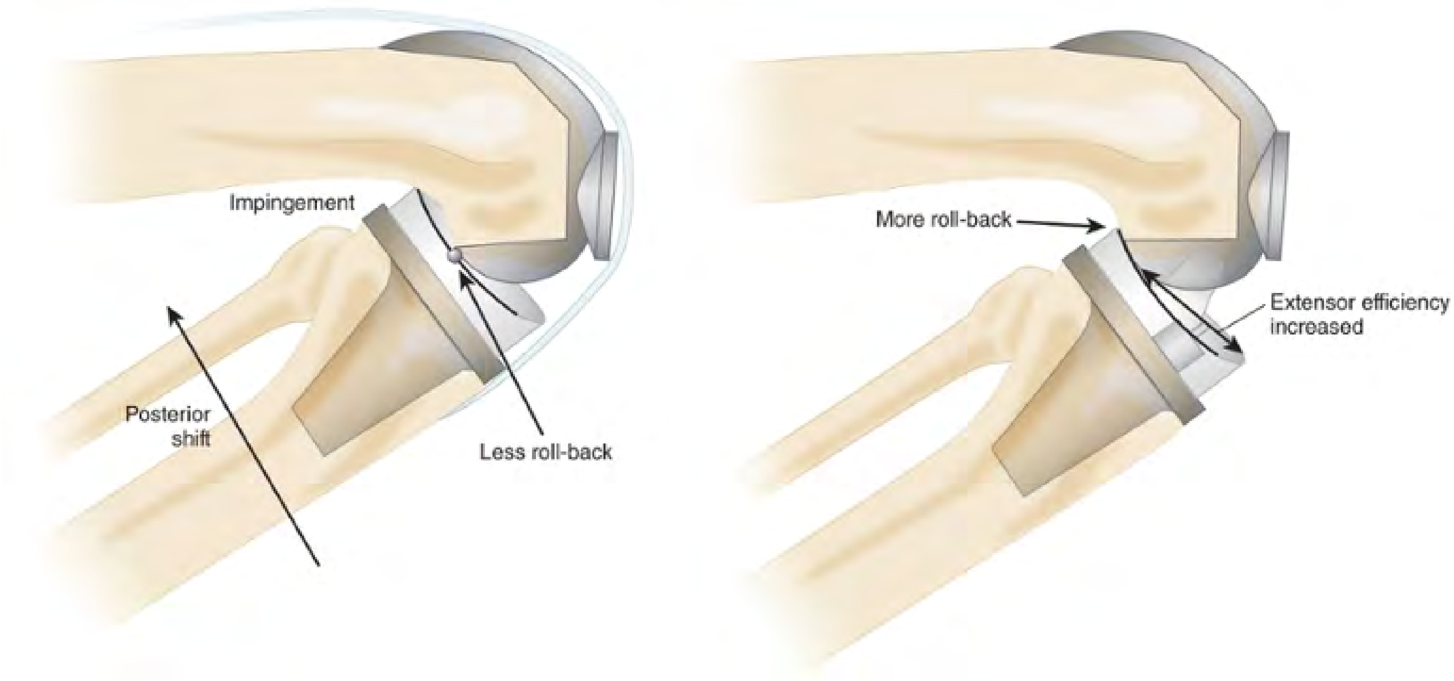

FIG141.1 Comparison between kinematics of cruciate-retaining (left) and post…

Features of the Middle Eastern Knee

Systemic Features

The systemic features that set the Middle Eastern patient apart from other populations are osteopenia, ligamentous laxity, and metabolic syndrome. Osteopenia is quite prevalent in the Middle East despite the sunny climate. This may be because of vitamin D deficiency, particularly in females, because of low sun exposure. This has been studied extensively and has been demonstrated in the literature, with some rates reported as high as 30% of the population and with a higher proportion in females.[3,23] This plays a significant role in TKA in the Middle Eastern patient, therefore minimizing bone loss in these patients is even more significant than in other populations. A specific complication derived from this feature is periprosthetic insufficiency fracture, which can be seen with severe varus deformity where the lateral condyle becomes highly osteopenic because of unloading of the lateral condyle. When the deformity becomes corrected after TKA, the sudden increase in pressure on the lateral condyle can lead to a compression-type fracture of the lateral femoral condyle, which we have described in the literature.[38] This complication requires a revision procedure and should be kept in mind because it occurs because of the osteopenia and gross varus deformity, a combination frequently seen in Middle Eastern patients. The two main concerns of this complication are that this fracture is difficult to diagnose and is frequently missed on plain anteroposterior films (Fig. 141.2) and the extensive bone loss seen during the revision procedure because of adherence of the fractured bone to the femoral component when it is removed, further compounding the problem of bone loss (Fig. 141.3).

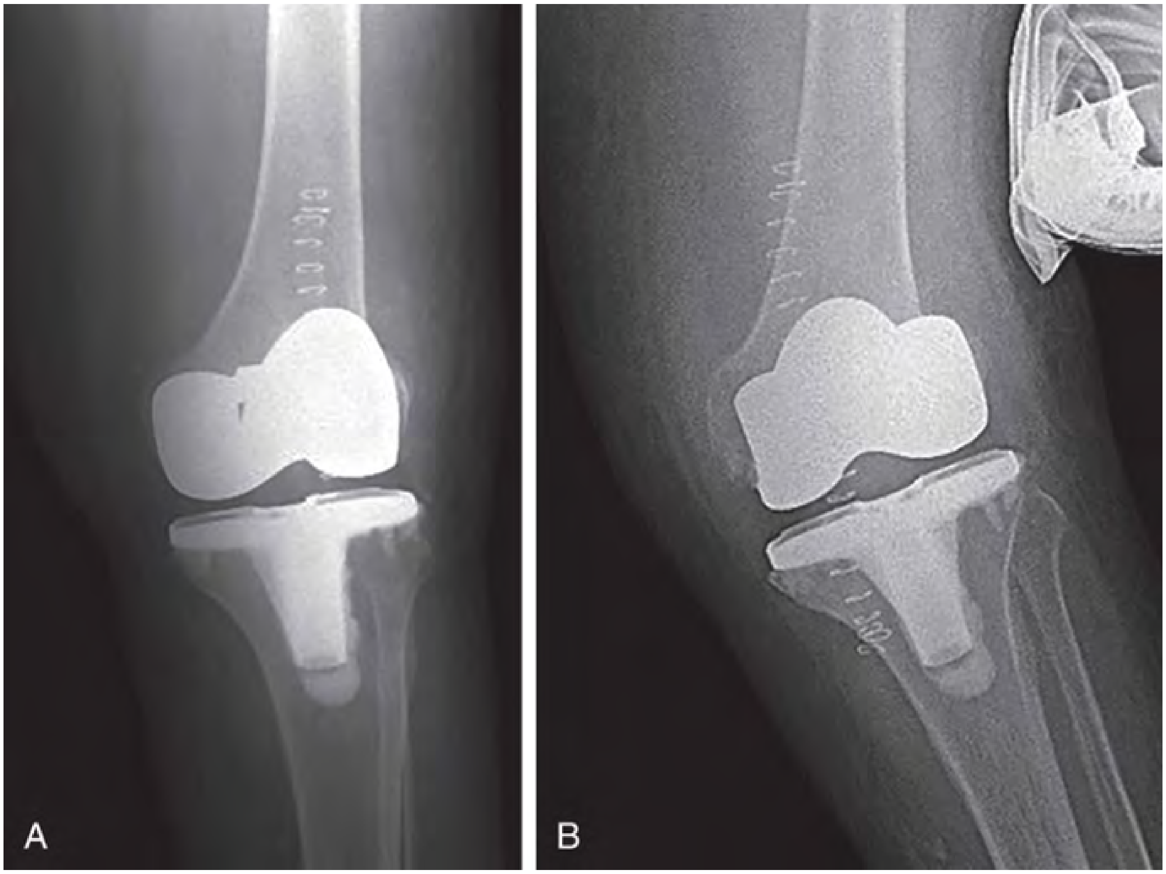

FIG141.2 Insufficiency fracture not apparent on plain AP film (A) but seen on s…

FIG141.3 Bone adherent to femoral component after removal during revision f…

Another concern that must be addressed because of the osteopenia is adequate bone coverage. The senior author advocates the use of an anatomic tibial component versus a symmetric component (Fig. 141.4). With a symmetric component the surgeon is often forced to insert the plate in internal rotation to have a more complete coverage of the bony surface, and this may lead to the surgeon sacrificing the posterior edge of the tibia. The anatomic tibial component provides more coverage and gives the surgeon more freedom to place the tibial component in proper rotation.[17] This is especially important in the Middle East because the body mass index of these patients is especially high (Table 141.1). We should therefore try to cover the tibial surface perfectly to prevent subsidence of the tibial component.

FIG141.4 Comparison between tibial components between NexGen and Person…

TABLE 141.1 Body Mass Index of Senior Author's Patient Population
Courtesy Dr. Samih Tarabichi, MD.

BODY MASS					
	Under Weight	Healthy Weight	Over Weight	Obesity	n
Index	>18.5	18.50-24.99	25-29.99	>30	—
Joints	2	35	149	502	688
Bilateral	1	14	64	212	291
Single	0	7	21	76	104
Patients	1	21	85	288	395
%	0.25	5	20	75	1.0025

The second feature is ligamentous laxity. This is seen in the broader Asian population and not just limited to the Middle East, with studies in the Far East and Southeast Asia showing significantly more anterior cruciate ligament (ACL) laxity in Asian populations when compared with white populations.[21,24] This laxity coupled with the advanced disease presentation makes the use of cruciate-retaining implants difficult because it may lead to instability. This laxity may dictate the use of more constrained implants, as seen with rheumatoid arthritis.[29,49] This concept also reinforces the need for the surgeon to be conservative with his or her bone cuts because aggressive resection of bone may result in the need for a thicker polyethylene spacer to fill the gap that has been made, and this may ultimately increase the risk of backside wear of the polyethylene component, which will decrease implant longevity.

Metabolic syndrome has a particularly high prevalence in the Middle East, with figures reported to be as high as 60%.[39] Our registry data show that 43% of our patients have diabetes. This indicates that the typical Middle Eastern patient has more co-morbidities preoperatively than a Western patient. This also has implications for the outcome of TKA as Amin et al. demonstrated, as when compared with nonobese patients showed lower mean knee society scores and had a lower rate of 5-year survivorship.[4]

Local Anatomic Features

Variations in the anatomy of the knee have been studied heavily in recent years, with earlier studies focusing on gender-based differences, followed by attention to differences across ethnicities. This first came to attention when it was realized that the female-specific implants were more compatible with Asian knees of both genders. The senior author used the NexGen system, and when the gender implant became available our registry data showed that 63% of the implants used in our patients were gender implants in both males and females of Middle Eastern ethnicity. Studies confirmed the differences between the genders, with the female distal femurs smaller and narrower than male femurs (Fig. 141.5). Female tibias were also smaller and had greater mediolateral versus anteroposterior ratios compared with male tibias.[6]

FIG141.5 Comparison of distal femurs between males and females. (Courtesy Zi…

With regard to Asian anatomy, there are documented differences in the distal femur, the tibia, and the relationship between the tibia and the femur. Urabe et al. showed that Japanese women had smaller anteroposterior and metaphyseal widths of the femur, but the posterior condyle was longer in Japanese women.[47] Fig. 141.6 demonstrates the difference in the width of the metaphyses between Asian and Western populations, with the Asian metaphysis assuming a triangular shape as compared with the Western metaphysis, which is trapezoidal. The narrow metaphyses makes it difficult to accommodate large housing mechanisms for the stems. The longer posterior condyles demonstrate the posterior offset we see in Asian femurs, and this is most likely to accommodate deep flexion (Fig. 141.7). Distal femoral rotation is also markedly different, with Yip et al. demonstrating a posterior condylar angle of 5.1 degrees in Asian males compared with 3.5 degrees in a study by Berger et al., which was performed on whites, indicating external rotation of the femur is greater in Asians.[9,53]

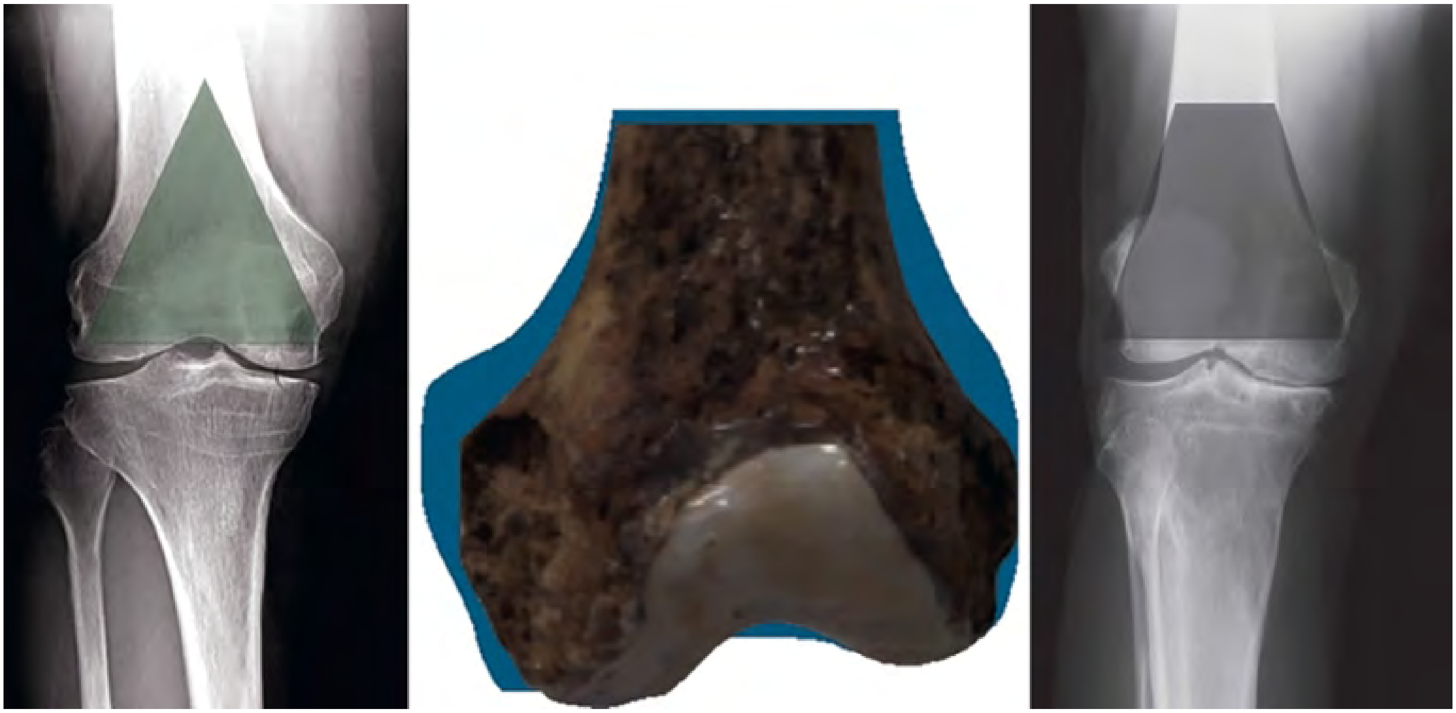

FIG141.6 Width of metaphyses between Asians (left) and Westerners (right) w…

FIG141.7 Asian knee superimposed on white knee, demonstrating posterior off…

Tibial differences should also be taken into account. Kwak et al. evaluated the proximal tibia and attempted to match the tibias to the most appropriate size of tibial implant. They found that implants with smaller anteroposterior dimensions were not large enough in the mediolateral dimension. On the other hand, the implants with larger anteroposterior dimensions showed mediolateral overhang.[27] Offset of the tibial shaft from the tibial plateau has also been noted in Asian populations. Yoo et al. have shown that the medial offset stem, which is based off anatomic studies in white patients, may not be appropriate in Korean patients.[54] Tang et al. performed magnetic resonance imaging scans on the tibial plateau and proximal part of the tibial shaft and found that the axis of the tibial shaft is anterolateral to the center of the tibial plateau in Chinese individuals.[41] With this variation in offset of the shaft form the plateau, if the offset is not predicted accurately it can lead to impingement or varus or valgus malalignment (Fig. 141.8).

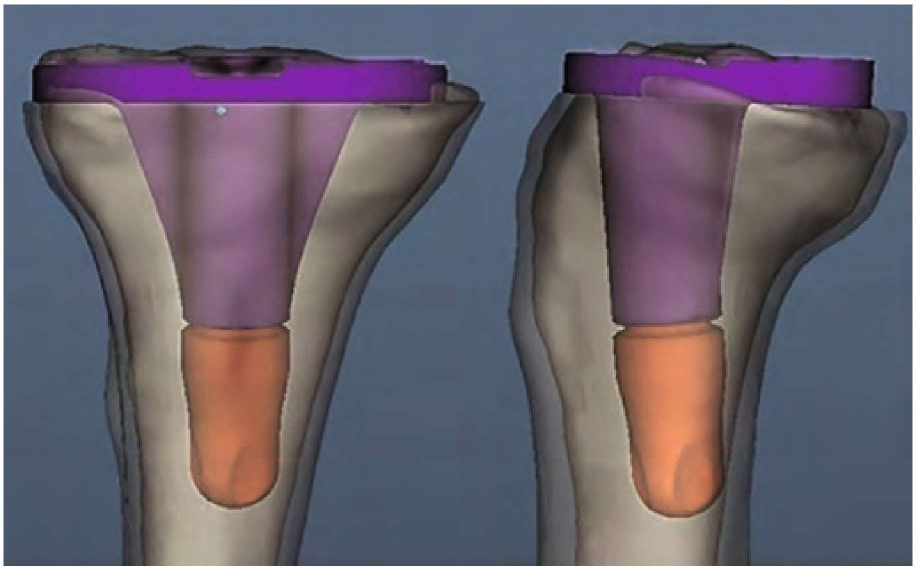

FIG141.8 Use of a medial offset stem in an Asian tibia. (Courtesy Zimmer Biomet.)

Tibial slope in Asian populations is also greater than in Western populations, with the tibial slope of Western patients being 10 degrees. Chiu et al., found that the slope of the medial tibial plateau is 14.8 and 11.8 degrees in the lateral tibial plateau in Chinese populations (Fig. 141.9).[15] The increase in slope seen in Asian populations is most likely to accommodate high flexion because increases in tibial slope have been shown to increase maximal flexion.[7]

FIG141.9 Differences in posterior tibial slope. Asian knee (left). Western knee …

With regards to alignment, Japanese subjects have also been

Features of Advanced Disease

This feature of Middle Eastern patients is because of the advanced presentation of disease. Patients in this region often present with gross varus deformity of 30 to 40 degrees (Figs. 141.10 and 141.11) and lateral thrust during gait, indicating instability.[13] This makes the procedure quite challenging. Advanced disease indicates there is some bone loss, as well as laxity and stretching, of the lateral side because of the severe varus deformity. Such severe deformity requires extensive release to balance the medial and lateral compartments, and this may lead to instability owing to the extensive release of the medial and lateral collateral ligaments. This makes the use of cruciate-retaining implants almost impossible. This instability may require use of more constrained implants, such as the constrained condylar knee (CCK) (Zimmer Biomet). This can be problematic because it limits the surgeon's options for future revisions. We now have the constrained posterior stabilizer (CPS) insert (Zimmer Biomet), which has a higher and wider spine that locks into the intercondylar notch (Fig. 141.12). This is useful in cases of extensive release in which a simple posterior stabilizer will not suffice, and the CPS insert provides midlevel constraint between the CCK and simple posterior stabilizer.


A
B
C
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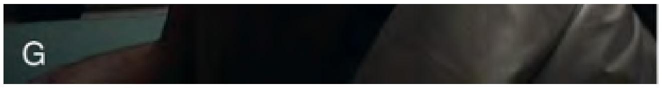

FIG141.10 Sixty-four-year-old male with gross varus deformity, along with pr...

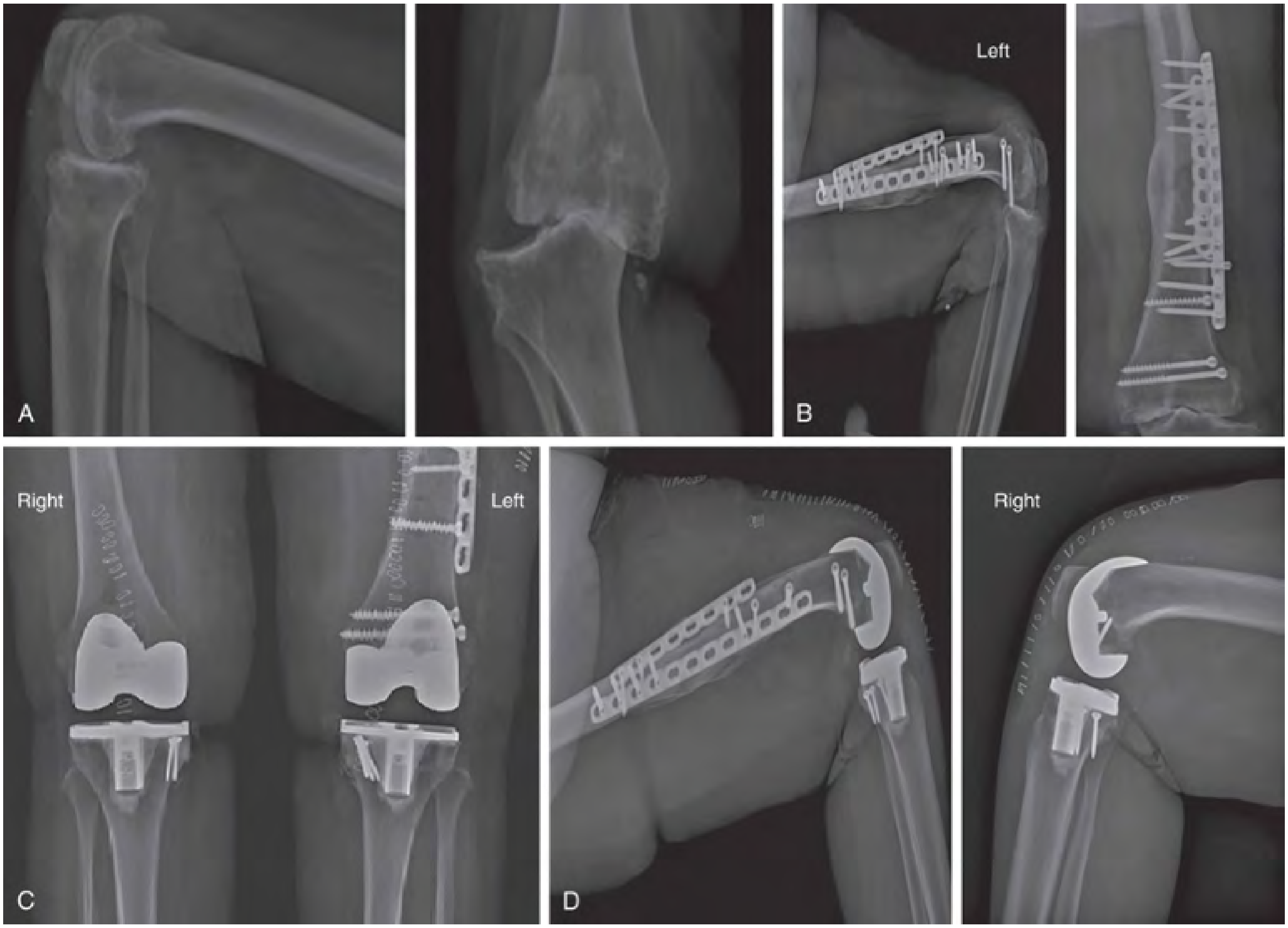

FIG141.11 Fifty-three-year-old female with a history of open reduction and in...

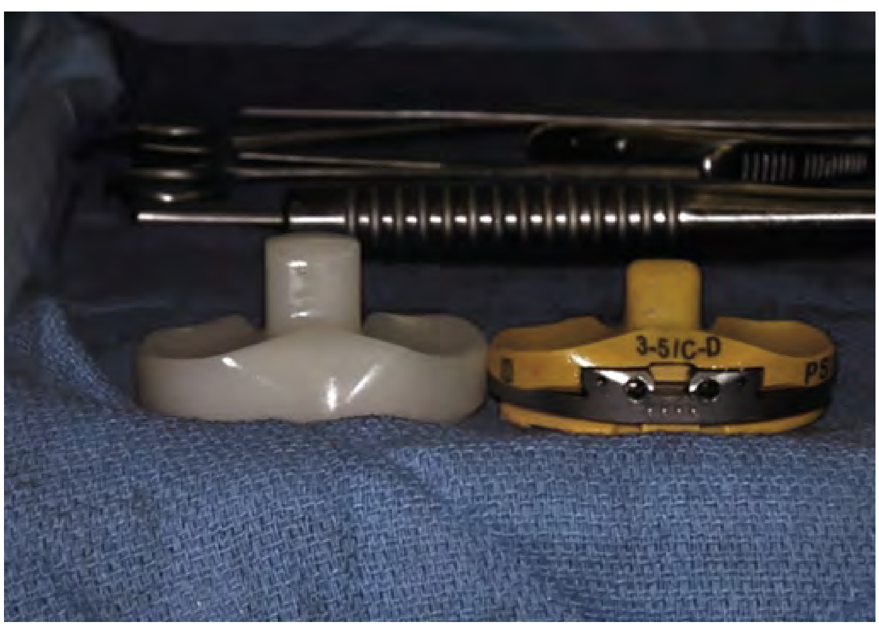

FIG141.12 Constrained posterior stabilizer insert (left) versus simple posterior

Activities of Daily Living

Asians perform a great deal of kneeling in their daily lives and in Middle Eastern patients even more so. Many patients lack conventional toilets and hence prefer to squat. Many patients pray five times daily, with Saudi Arabian men flexing on average up to 159.6 degrees during prayer.[1] Fig. 141.13 displays positions commonly assumed by Asians, with kneeling and squatting featuring particularly in the Middle East. We have performed kinematic studies on frequent kneelers to study tibiofemoral movement in deep flexion using a three-dimensional (3D) C-arm (Siremobil Iso-C 3D, Siemens, Munich, Germany), and we showed that to kneel we need freedom of rotation of the tibia on the femur.[42] It is essential to understand the functional requirements of patients in the Middle East because many patients will refuse surgery out of fear that they will lose range of motion.[33] Thus we must bear in mind that high flexion past 130 degrees is important in these patients, and we will address how to achieve this in the operative section.

FIG141.13 Activities of daily living in Middle Eastern individuals (A). (From Ack…

FIG141.13 (B and C) Full flexion in kneeling post TKA. (Courtesy Dr. Samih Tarabic...

Surgical Considerations for the Middle Eastern Knee

This section will cover two aspects: choosing the right knee system and preoperative assessment.

Choosing the Right Knee System

The original knee systems were designed with mainly white patients in mind because it was based on averaging calculations for the white knee, which may not fit some Middle Eastern patients (as discussed previously). Preoperatively the surgeon should be very careful about his system selection, particularly in the small knee. Smaller Middle Eastern knees are quite challenging and unfortunately will not tolerate errors as compared with larger knees, which might be more forgiving. We are not in any way advocating any particular system, but we do believe that the surgeon should closely assess the system he or she intends to use on a smaller Middle Eastern knee.

Starting with the femur, we have discussed previously that the Asian knee has a posterior offset to accommodate deep flexion. This guides the surgeon to the use of a narrower implant. Use of the standard width implants made for white patients may lead to overhang of the components of the Asian knee. The width of the box cut is another factor that must be taken into consideration. Significant variation exists between prostheses in the amount of intercondylar bone that is resected to accommodate the posterior stabilizer mechanism.[20] This is crucial because excessive bone resection can lead to periprosthetic fracture.[2] We also advocate the use of a system that allows freedom in setting the external rotation of the femoral component because, as has been reported in the literature, 3 degrees of external rotation is often not adequate in severe gross valgus deformity.[51] The system should allow more freedom in setting higher external rotation for the femur, which might reach up to 8 degrees.

On the tibial side, we have mentioned the utility of an anatomic tibial component, which will allow for better coverage and more precision in setting the rotation. This is preferred to obtain a balance between adequate coverage and proper rotation.[17]

An important aspect in keeping with the concept of the smaller dimensions of the Asian knee is looking at the difference in increments between the sizes in each system. The majority of systems that were initially available on the market had an increment of 4 mm. Some systems have 5-mm increments, and this is a great injustice to the Middle Eastern knees because it forces us to take much more bone to change from one size to another. We have a graph demonstrating the magnitude of the increments across different knee systems (Fig. 141.14). Another important point is that if you mismatch the flexion and extension gaps, a larger knee will be more forgiving in a posterior stabilized knee for larger sizes (Fig. 141.15). However, in smaller sizes a mismatch of the same size would be disastrous because the spine may disengage and dislocate. We advocate the use of systems that have 2-mm increments, particularly in the smaller sizes, because 2-mm increments are much more precise in balancing the flexion and extension gaps. Fortunately the industry has become more accommodating and has released systems with 2-mm increments (Fig. 141.16).

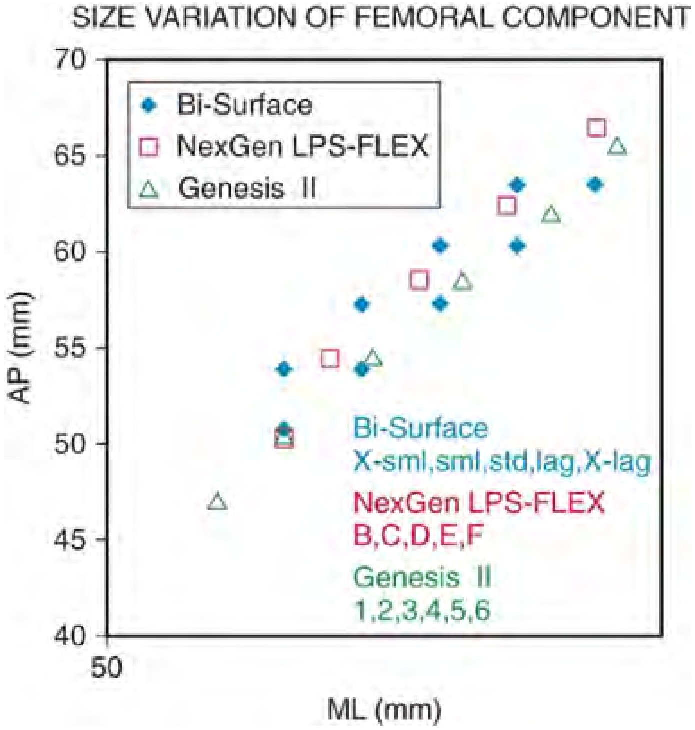

FIG141.14 Size variation of femoral component among different systems. Mo…

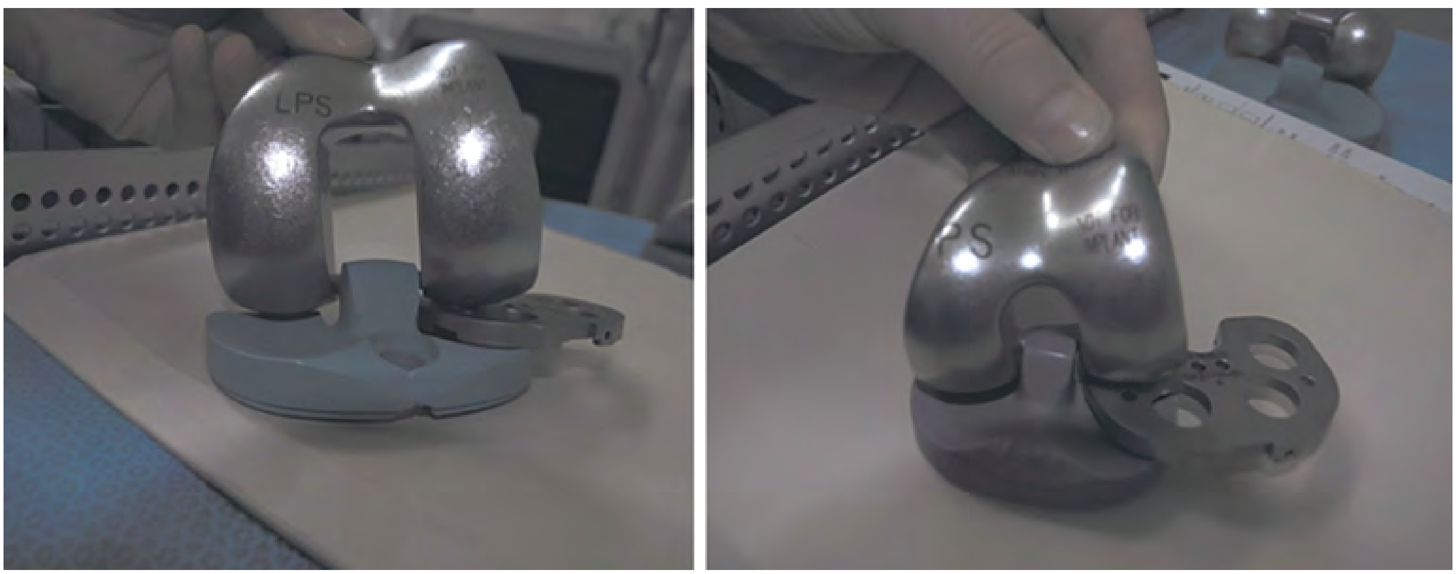

FIG141.15 Figure demonstrating 3-mm mismatch in larger (left) versus small…

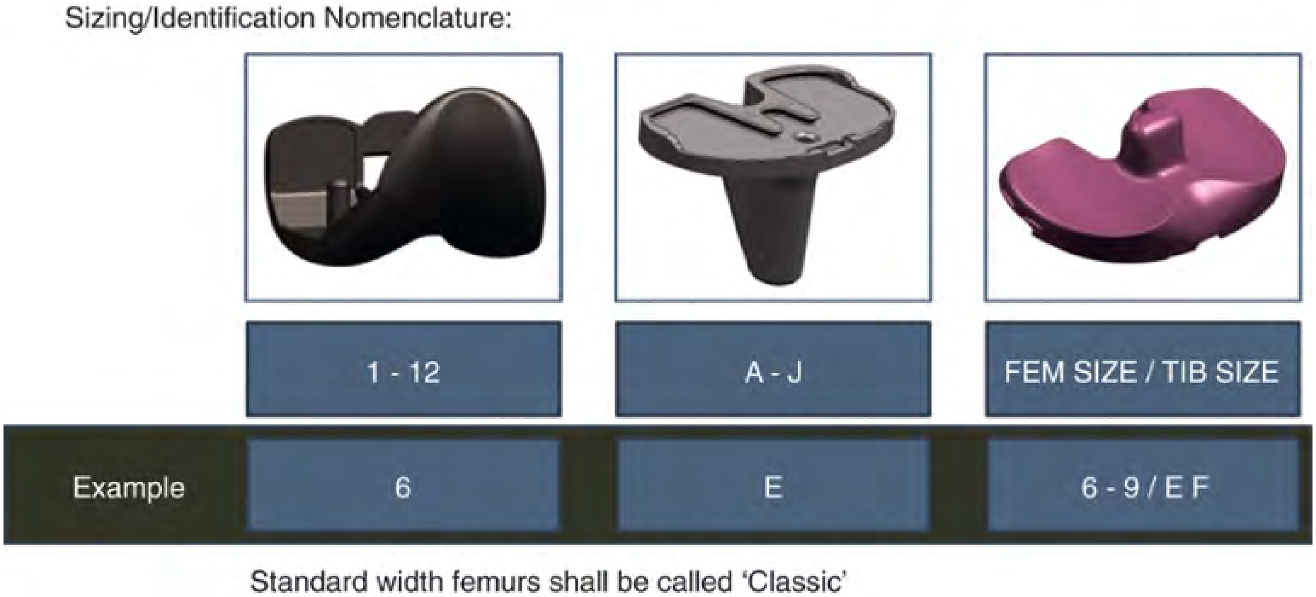

FIG141.16 New sizing system in Persona System is more compatible with Asi...

The second thought that we have to bear in mind when choosing a system is financial considerations. The majority of hospitals have limited budgets and cannot keep multiple options stored in the hospital, so they will force their surgeons to buy only one system and it is definitely safer to choose posterior stabilized rather than cruciate-retaining prostheses. Throughout this chapter we have made the case for a posterior stabilized implant. The senior author used to advocate for a cruciate-retaining implant until he moved to the Middle East and converted to posterior stabilized implant. We will not go into the discussion over whether cruciate-retaining or posterior stabilized is better; however, for the Middle Eastern knee the posterior stabilized prostheses is a much safer choice. We have used cruciate-retaining implants sporadically, but only in cases in which deformity was minimal and the ligament was intact. The relevance of this debate to finance is the inability to carry both systems at the same time because of monetary constraints, and this is an issue we faced in the Middle East. We believe posterior stabilized implants are a better choice for the full spectrum of Middle Eastern patients.

There are also implants that have given consideration to high flexion, and they should be used in Middle Eastern patients. However, it is key to know that the implants themselves do not provide high flexion but may be friendlier for deep flexion because many systems have not been assessed kinematically beyond 120 to 130 degrees of flexion.

Knee systems with higher constraint must also be available. In patients with complex deformity the initial instability coupled with the extensive release results in instability with a regular posterior stabilizer. As we discussed previously, this necessitates the use of a CCK, and we have used it in 5% of our primaries. The CCK provides medial and lateral stability. If there was any significant instability with the trial components because of the extensive release, then we proceeded to use a CCK implant. Thus in severe deformity a backup system should always be kept close by because the instability cannot be appreciated until after the bone cuts are made. We are now fortunate in that the CPS insert that has been released provides midlevel constraint between the regular posterior stabilizer and the CCK.

Another consideration is whether to choose mobile- or fixed-bearing implants. The principle behind mobile-bearing implants is to provide greater freedom of rotation. We have published work on the kinematics of the knee in daily activities and we have shown that in deep flexion there is significant rotation of the femur on the tibia (Fig. 141.17).

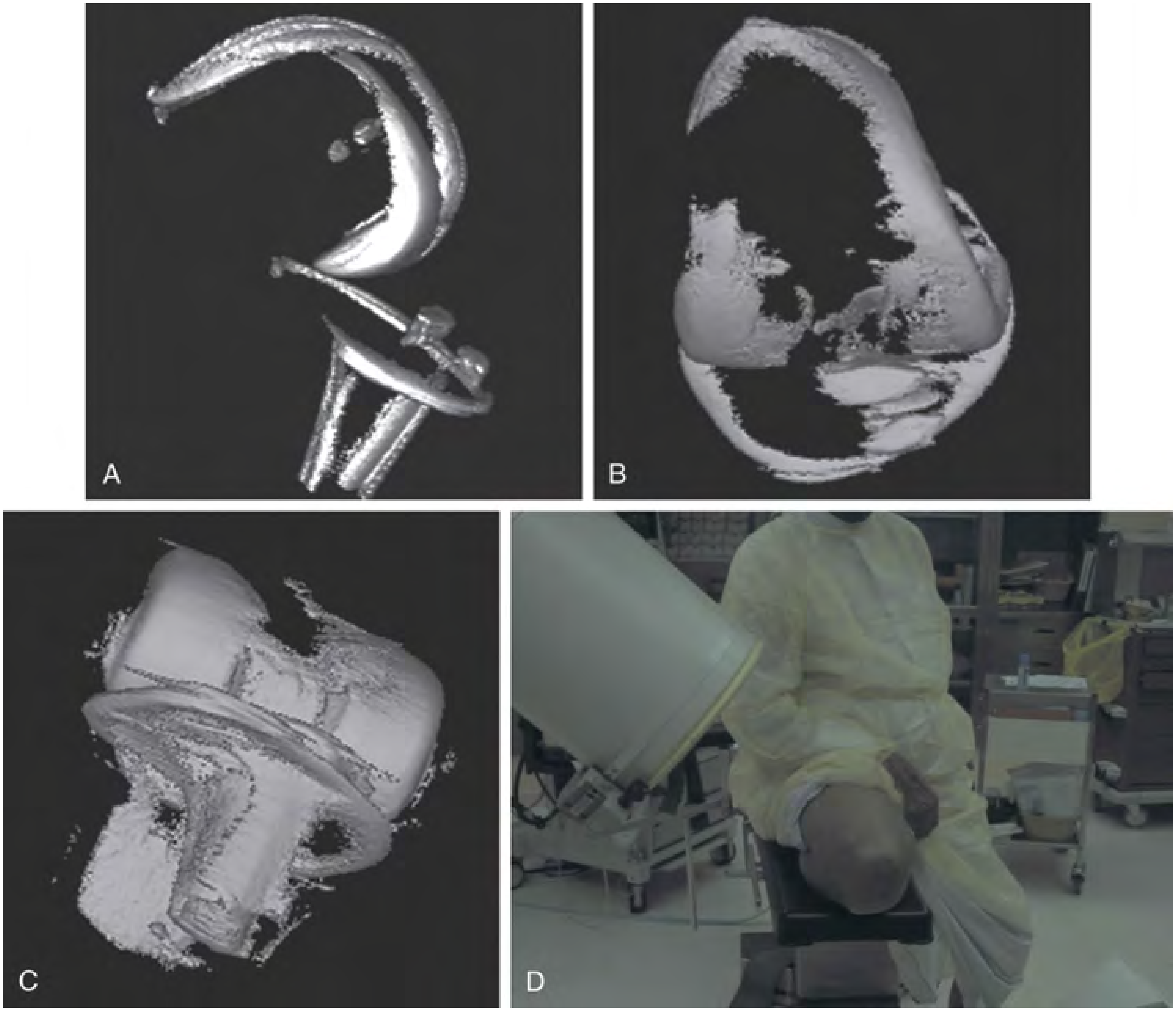

FIG141.17 Three-dimensional (3D) images showing rotation of the femur on …

We have also presented at the American Academy of Orthopaedic Surgeons (AAOS) annual meeting,[43]comparing the outcomes of mobile-and fixed-bearing knees in Middle Eastern patients. Although there was no significant difference in range of motion between mobile- and fixed-bearing knees, there was a higher percentage of frequent kneelers in the mobile-bearing group. Frequent kneelers were defined as those who kneel more than 5 times a day. This is most likely because of the increased rotation permitted by the mobile-bearing implant, making the patient more comfortable in deep flexion. We believe this is because of lack of rotation in the fixed-bearing knees. In other words, if the femur does not rotate to its normal position when kneeling, the patient will feel the ligaments around the knee to be tight and will be stretched, causing pain and discomfort, and so we recommend mobile-bearing prostheses in patients with low body mass index who are likely to achieve full flexion. However, the increased frequency in the mobile-bearing group came at a price, with the mobile-bearing group having a higher rate of dislocation. We should stress that mobile-bearing implants can dislocate even if the flexion and extension gaps are perfect. If the patient has severe deformity and after soft tissue balancing there is some instability, we prefer not to use mobile-bearing prostheses, out of fear that the knee might sublux.

Cemented versus Cementless Total Knee Arthroplasty

Our discussion about choice of implant is not complete without going over the debate between cemented and cementless TKA. Our main indication is a younger patient, as has been shown in the literature as well.[52] We now perform only cementless TKA in patients younger than 55 years and/or a life expectancy of more than 20 years. Cementless TKA has gained popularity as more data emerges demonstrating the increased incidence of osteoarthritis in younger populations.[26a] We have now performed more than 1400 cementless TKA procedures, at an annual rate of 200 per year. Our series shows that the majority of patients with cementless TKA have been younger than 60 years of age. The reason for success is greater integration between the bone and the implant, with bone growing into the implant after cementless TKA (Fig. 141.18). The disadvantages associated with cemented implants were also a reason for the success of cementless TKA. In cemented TKA, we had greater bone loss after revision during removal of the prostheses (Fig. 141.19). Furthermore, in infected TKA, it is much easier to remove all of the foreign material in cementless TKA in a two-stage revision, and this will allow eradication of infection. However, in cemented TKA, it is very difficult to remove small pieces of cement that is interdigitated in the bone, and if even a small amount of bone cement residue is left it might be a reason for failure because of failure to remove all the foreign bodies in two-stage revisions.

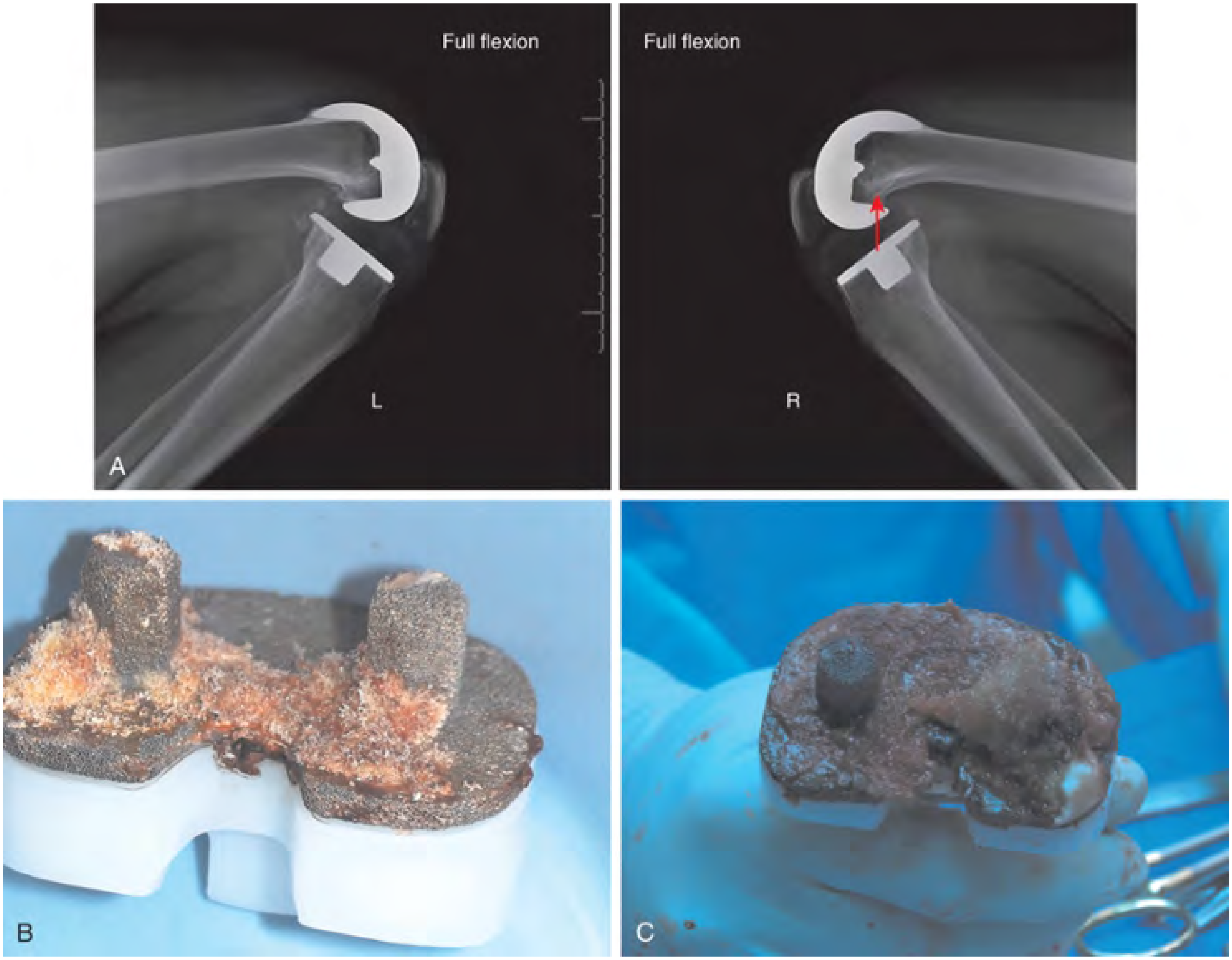

FIG141.18 A, Bilateral lateral view radiographs of cementless TKA demonstra…

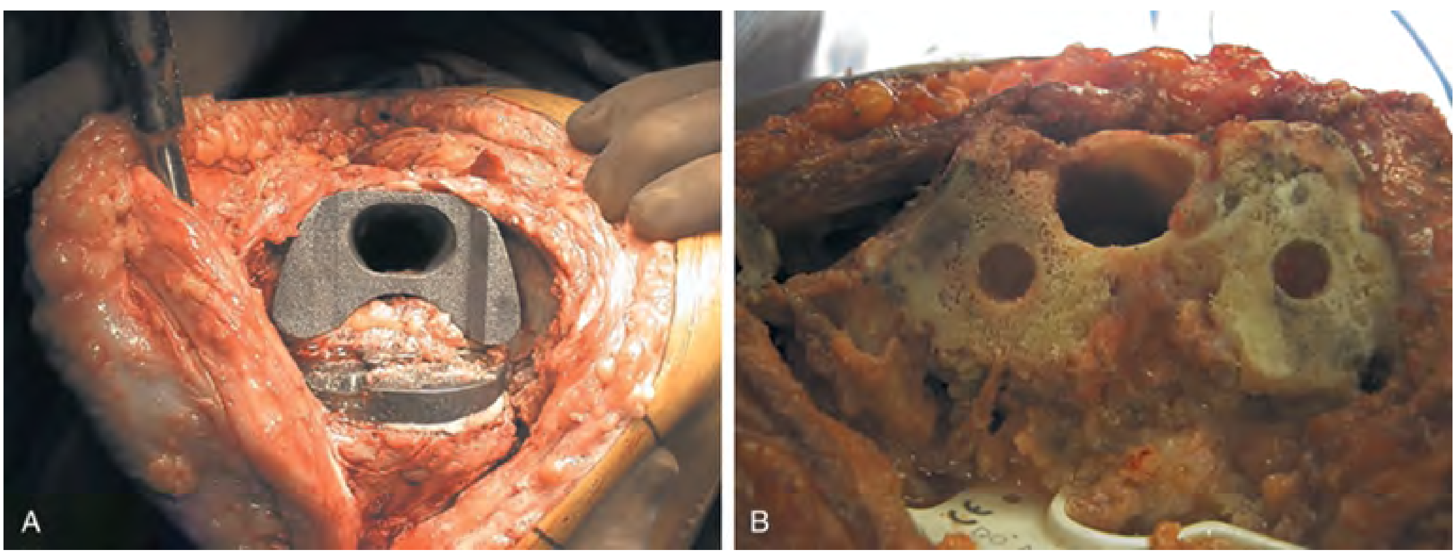

FIG141.19 Greater bone loss seen with revision after primary cemented TKA …

One of the great advances in implant design that has encouraged the use of cementless implants is the advent of the metal tantalum. Tantalum has been used clinically for many years in pacemakers and cranioplasties, among other uses. Porous tantalum has a unique trabecular shape with pore sizes of 400 to 500 μm. Porous tantalum also has a stiffness similar to cortical bone. These properties make porous tantalum more physiologic, allowing it to move properly within the bone and become more integrated within the bone. The biocompatibility of tantalum can be observed during the revision of a cementless implant during removal of the components, and one will see significant bone growth on the implant.

The concern about cementless implants early during the 1980s was that we had multiple failed designs of the tibial component and great reluctance among surgeons to perform cementless TKA. Femoral components have never been an issue on review of the literature. Most of the literature has shown that cementless tibial components were problematic. Patella failures have also contributed to failure of cementless TKA.[8] Thus our practice has been to not resurface the patella. However, more recently, a cementless monoblock tibial component has demonstrated 96.8% survivorship at 20 years, which is quite impressive.[37]

Our clinical experience with cementless TKA has been excellent. We had the same clinical outcome in our series when compared to cemented. We had five cases of revision for femoral loosening and three cases of infection, which recovered completely. We also achieved similar range of motion in cementless TKA. We used a cementless posterior stabilized tibial monoblock. We previously used a tantalum tibia and titanium fever, but now with the release of the tantalum femur we use tantalum for both components.

Preoperative Assessment

At our institution we have a dedicated “knee day,” when the patient’s medical condition is thoroughly assessed. The physiotherapist also sees the patient, and we inform the patient what to expect postoperatively.

In our preoperative assessment, we normally flag cases which may be technically difficult. These cases include those with gross deformity, valgus deformity more than 20 degrees, flexion contracture, bone deformity proximal to the knee, osteoporosis, and nonambulating patients. In these cases, we obtain standing alignment radiographs to assess their deformity and plan for their surgery. These flagged cases, such as a revision system, are readily available. We also prefer to perform simultaneous bilateral TKA in patients with severe deformity, and the logic behind this is that if we have a gross flexion contracture and we correct one side only then the contracture recurs on the operated knee. Furthermore, unilateral surgery can result in leg length discrepancies in patients with bilateral varus deformity.[48] Although initially there was great reluctance in the West to perform bilateral TKA, it has become routine in Asia. There is now a wealth of evidence to support bilateral TKA, with some studies showing a lower incidence of infection when comparing bilateral TKA with staged unilateral TKA.[32] It has also been shown that there is no significant difference in mortality between the two,[22] with bilateral TKA being more cost effective and having less overall hospitalization time.[34]

Simultaneous bilateral TKA is a necessity in some Middle Eastern patients. However, it is also a complex procedure, and our medical team must thoroughly assess the patients to see if they can tolerate bilateral TKA. We must advise surgeons against jumping into simultaneous bilateral TKA until they have an adequate medical team to support them. Furthermore, bilateral simultaneous TKA has been associated with higher rates of transfusion,[28] and we have found in a study we performed that tranexamic acid is useful in reducing blood loss after bilateral simultaneous TKA.[31]

We also perform bone density scans on our patients because of the prevalence of osteoporosis. We do not advocate delaying surgery to treat the osteoporosis because this in itself is a long process and many patients are quite disabled by their deformity; furthermore, the osteopenia arising from disuse might progress. We do it mainly to plan postoperative treatment and to draw the patient’s attention to this problem and so that they can receive the appropriate treatment.

Intraoperative Considerations

As mentioned earlier, most of our TKR procedures are done as simultaneous bilateral surgeries. We have discussed why we do simultaneous bilateral surgeries because of the gross deformity, and it is more economically feasible and there are now multiple studies in the literature, as revealed earlier, that show the efficacy of simultaneous bilateral TKA.

We have tried different modalities of simultaneous bilateral replacement using one team or two teams, and we have tried different ways based on the number of assistants. However, after multiple trials and seeing multiple surgeons performing simultaneous bilateral TKRs, we concluded that the best way is to have an operating team consisting of one senior surgeon, two assistants, and one scrub nurse. Our setup is demonstrated in Fig. 141.20 in a schematic diagram. This decreases the number of people in the room, making the procedure smoother. The diagram demonstrates how we recommend arranging the operating room staff and equipment for the simultaneous bilateral TKR. Normally the operating surgeon starts on one side and the two assistants will be helping him or her, one across the table and one on the same side. After cementing the first side, then the other team will proceed with the left side. The tourniquet is inflated on the left side only after the first knee is cemented and the polyethylene insert has been placed. One assistant will start closing the operated side; the other assistant will start exposure along with the operating surgeon, and the procedure is finished as such. We found that increasing the number of assistants makes the procedure more difficult and more confusing. We normally prep both sides together (Fig. 141.21); however, we inflate first the first side, and on closure the tourniquet on the other side is inflated.

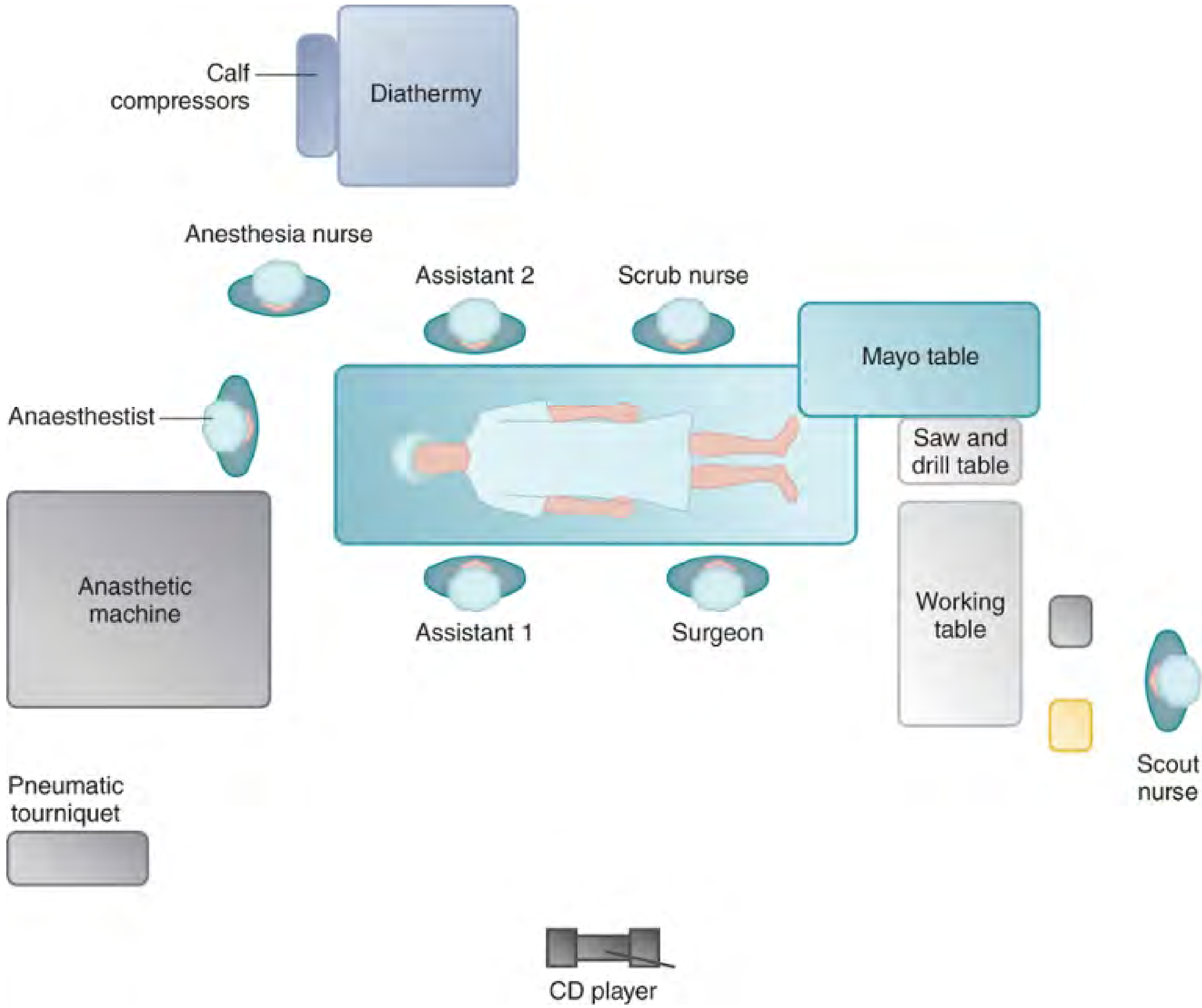

FIG141.20 Diagram showing layout of operating room in simultaneous bilater...

FIG141.21 Both knees are prepared at the same time in bilateral simultaneou…

We have tried two teams operating independently; however, we found that there is a lot of confusion in the operating room. The instrumentation will be crossing both sides, and there is no advantage with regard to the length of the procedure. Normally, simultaneous bilateral TKA takes approximately 2 hours, skin to skin, in the majority of our cases. We also recommend organizing the operating theatre where we normally select only the instrumentation we are going to use and keep it in a tray, as illustrated in Fig. 141.20. We keep the set of instrumentation away from the field to clear the field and to have it available when certain instrumentation is required.

Subvastus Approach and Anterior Quadriceps Release

We use a modified subvastus approach. We proceed through a medial parapatellar incision while maintaining the attachment of the vastus medialis on the patella, thus leaving it intact. We dissect the vastus medialis until it is laterally mobilized. After the extensor mechanism is mobilized, the underlying suprapatellar pouch is identified and excised, along with any adhering bands or fibrotic tissue (Fig. 141.22A and B).[46] This provides access to the deep interface of the quadriceps muscle, allowing our anterior quadriceps release to be carried out (see Fig. 141.22C and D). Our release is performed bluntly by dissecting the deep surface of the quadriceps away from the anterior surface of the distal femur, as well as both medial and lateral intramuscular septa. The release is carried out in an incremental fashion in which the knee is flexed after each release. If the range of motion is determined to be less than 130 degrees, the release is carried out more proximally along the anterior surface of the femur until a range of motion of more than 130 degrees is obtained. Fig. 141.23 illustrates the concept of the anterior quadriceps release. This approach allows greater excursion of the quadriceps and enables the surgeon to sublux the patella laterally without everting or dislocating it. This increased flexion will be helpful for the patient in his activity and aids the surgeon in performing his procedure by decreasing the tension on the soft tissue, decreasing the risk for avulsion of the patellar tendon or skin necrosis. This release is crucial in our patient population because of the importance of deep flexion to their activities of daily living. We previously thought that we could not achieve deep flexion in patients with restricted preoperative range of motion; the vast majority of literature reports that preoperative range is the strongest predictor of postoperative range of motion.[19,36] We performed a study in which we performed only the anterior quadriceps release, and bony resection, ligament releases, or lateral and medial retinacular releases were not performed at that point in surgery. The results of this study showed that, in all 42 patients, range of motion was significantly increased (Fig. 141.24).[45] This clearly demonstrates that inadequate excursion of the quadriceps muscle and tendon is the main limiting factor in better knee flexion. We have presented the results of our modified approach at the International Society for Technology in Arthroplasty in 2004 and concluded that minimally invasive techniques, such as midvastus and quad-sparing approaches, result in damage to the extensor mechanism. In our technique the extensor mechanism is maintained and patients were also shown to perform a straight-leg raise sooner than patients with a standard parapatellar incision.[18] The subvastus approach can even be performed in heavy patients because Asians have more relaxed soft tissue, making the subvastus approach easier. This approach is usually difficult in obese males in whom mobilization of the quadriceps is usually difficult. Another advantage of our approach is that if skin necrosis occurs in the proximal half of the incision, the intact muscle will prevent spread of sepsis into intra-articular spaces. We have had cases in which skin necrosis in the proximal half of the incision was quite deep. However, because the joint was covered with the vastus medialis muscle, we were able to treat with débridement and full-thickness skin grafts while preserving the implant, thereby avoiding deep infection (Fig. 141.25).

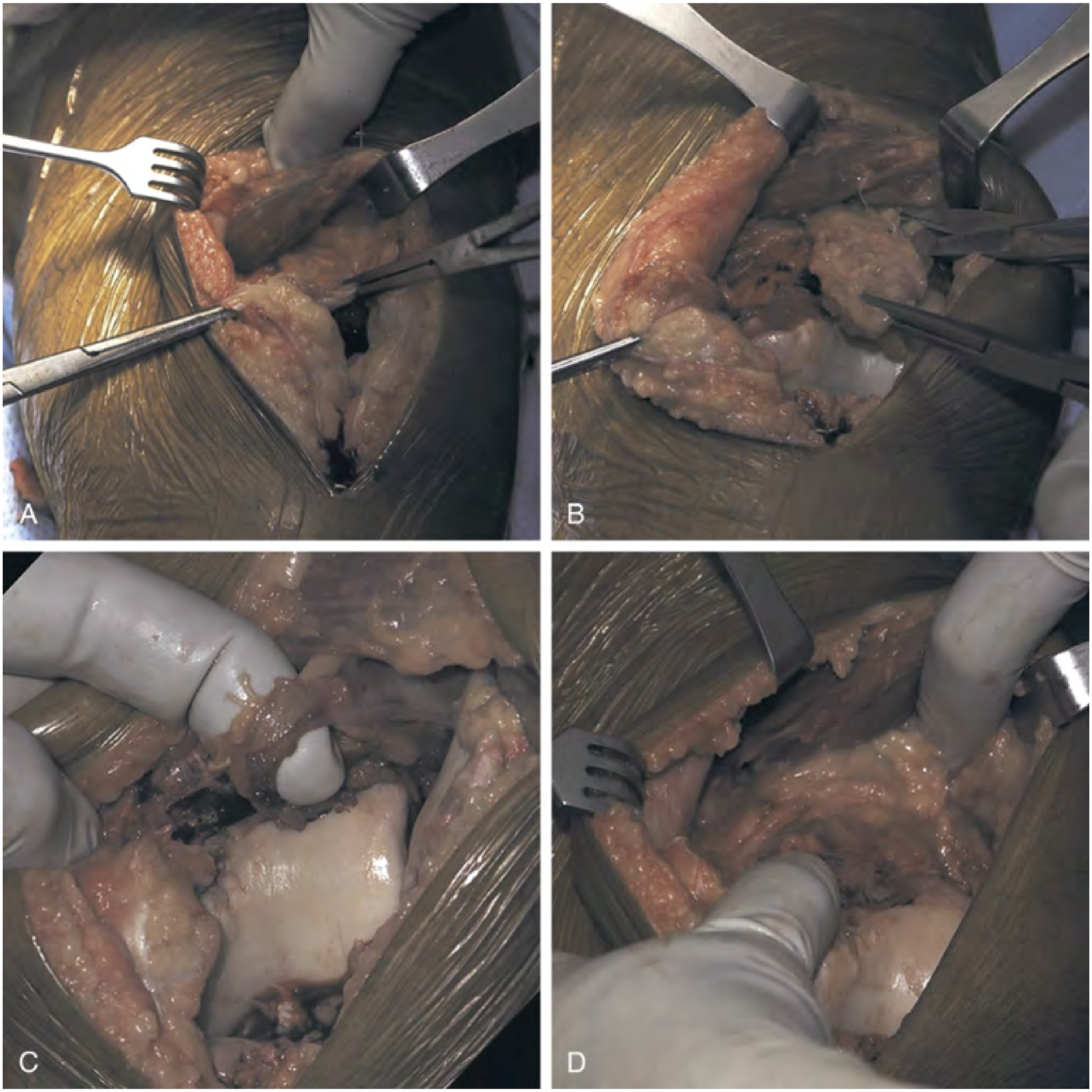

FIG141.22 Photographs of the Left Knee While Performing Quadriceps...

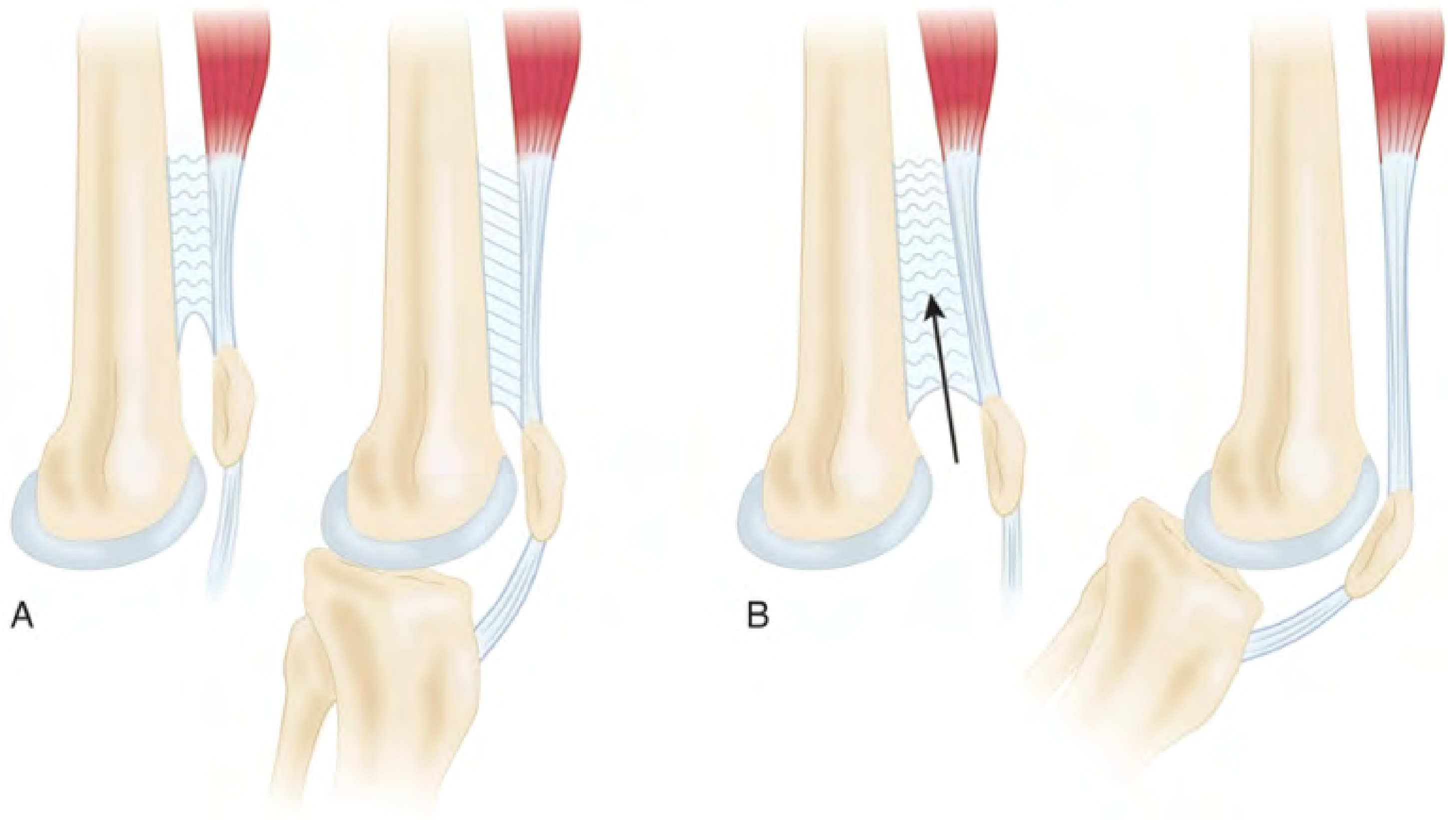

FIG141.23 Illustration simplifying the anterior quadriceps release. (From Tarabi...

FIG141.24 Seventy-four-year-old woman who underwent bilateral quadriceps...

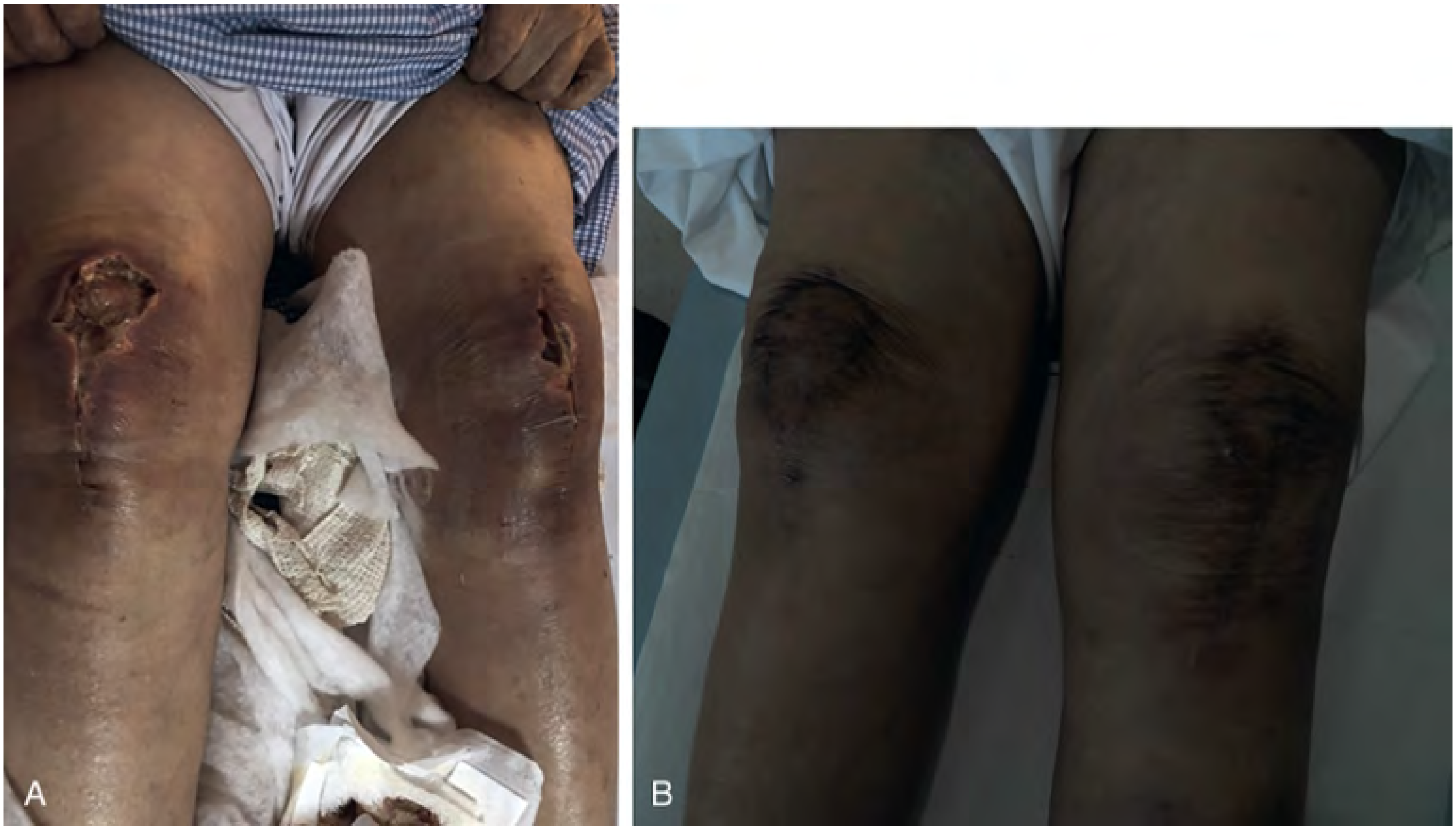

FIG141.25 Eighty-six-year-old male who developed superficial skin necrosis p...

After the subvastus approach, performing an anterior quadriceps release, and obtaining flexion of more than 130 degrees, the surgeon can then proceed with the bone cuts.

Bone Cuts

We normally start with a distal femoral cut using the intramedullary guide. Asian patients have been shown to have a higher prevalence of anterior bowing in their femurs.[40] Thus the surgeon should raise his or her hands when entering the intramedullary canal so as to get better alignment. In smaller patients, it is sometimes more difficult to insert the long intramedullary guide used for white patients. Telescopic distal femoral guides can be used, which will help the surgeon to adjust the lengths of the rod accordingly. After performing the distal femoral cut, we normally measure the amount of bone taken from the distal femur and try to match it with the posterior condyles. Normally we try to finish the distal femoral cut and then focus on measuring the resected amount intraoperatively to match the bone resected in flexion and extension. The guide for the distal femoral cut is used to perform the four bone cuts in one set. Most systems currently available allow you to do the anterior, posterior, and chamfer cuts using one guide.

The challenging thing normally is how to set the distal femoral rotation. As mentioned earlier, Asian populations tend to have an average of 5.1 degree of external rotation fit compared with 3.5 degree in white populations.[9,53] We prefer to use the transepicondylar axis, and determine our rotation using the medial and lateral epicondyles. This is quite important, especially in valgus knees in which the lateral femoral condyle is usually hypoplastic and posterior referencing to set the rotation might be quite misleading in the valgus knee[51] and in the patient who has had extensive posterior osteophyte formation. Thus we prefer a system that allows the surgeon to set the rotation based on the transepicondylar axis or the anteroposterior axis of the femur (Whiteside line).[51] We tend to try not to use the posterior referencing for rotation because in gross deformity the osteophyte will prevent proper placement of the rotation guide on the posterior condyle (Fig. 141.26). If the deformity is mild then posterior referencing can be used to set the rotation. However, it should be remembered that in Asian patients the angle of external rotation if referenced to the posterior condyle is approximately 5 degrees.[9,53]

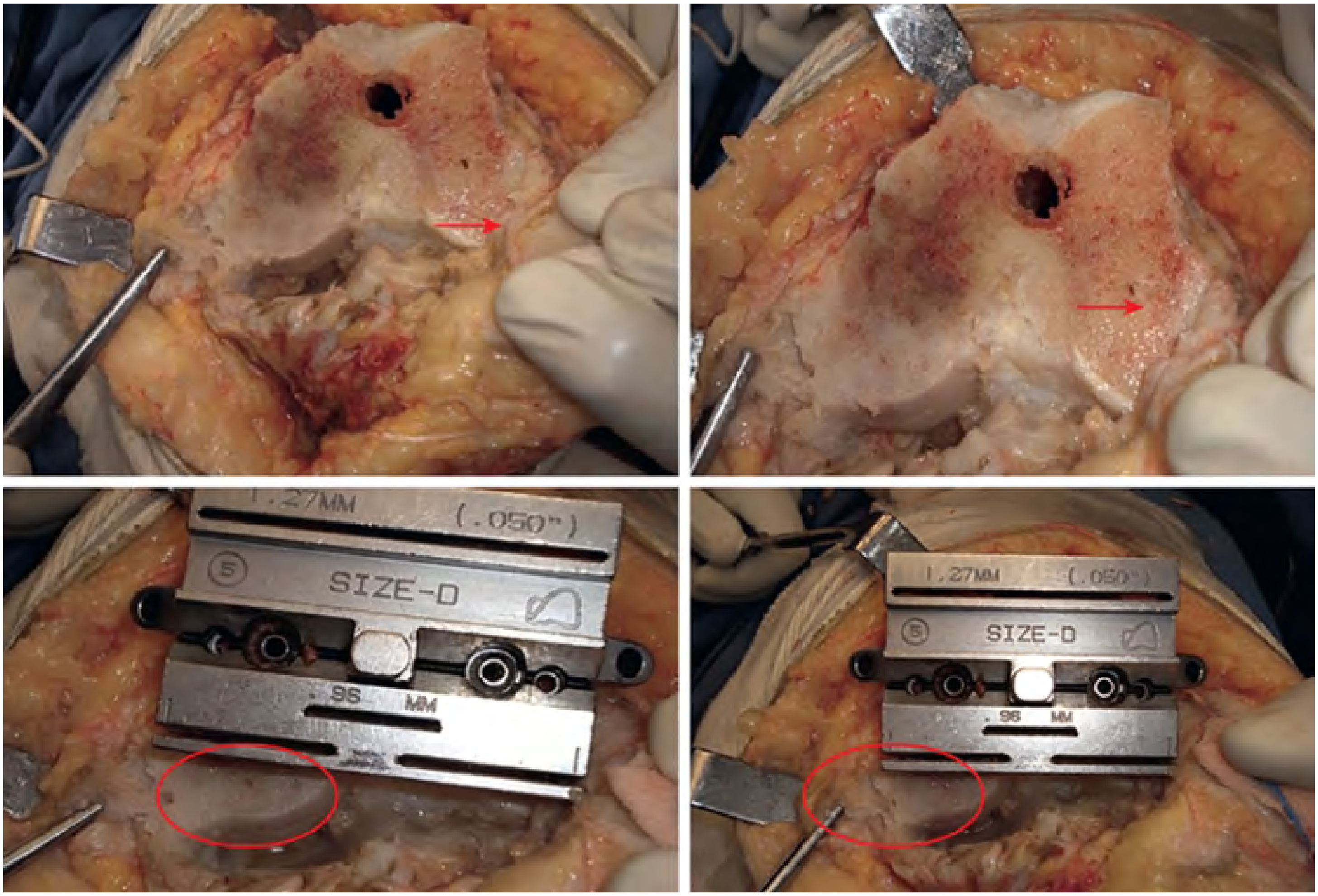

FIG141.26 Posterior osteophytes distort the posterior condylar line (red arrow..

After performing the distal femoral cut, we proceed to the tibial cut. We must stress that sometimes our patients in this region have significant tibial bowing and that intramedullary guides may lead to malalignment, so we normally prefer the extramedullary guide. The extramedullary guide gives a better orientation for the tibia and the surface of the tibia, keeping it at 90 degrees regardless of the bowing.[14] A key element of performing bone cuts on Middle Eastern patients, which we have discussed previously, is minimizing the cuts because Middle Eastern patients have laxer soft tissues, as well as more severe deformity. This leads to a much wider gap than the bone cut itself, due to balancing of the collateral ligaments. This problem is amplified in a posterior stabilized implant when the contracted PCL is resected. Conventional wisdom in TKA dictates that the thickness we resect is equivalent to the thickness of implant. We have performed caliper measurements of the thickness of bone resection in 200 of our patients (Fig. 141.27). The average deformity was 16 degrees in varus knees and 12 degrees in valgus knees; 187 of the 200 knees had a varus deformity. We measured the proximal tibial cuts, distal femoral cuts, and posterior femoral cuts. We found that, in varus deformity, we consistently resected bone that was much thinner than the implant thickness (both components added to the thickness of the polyethylene component). We also found that the lateral column cuts were much thicker than the medial because most of the bony erosion in our patients is on the medial side, due to the deformity (Fig. 141.28). Thus surgeons performing TKA in the Middle East should be careful not to follow the manufacturer recommendations of 8- to 10-mm bone cuts on the tibia and the femur because this will result in a large gap and the surgeon will have to resort to the use of a thick polyethylene component, which may ultimately lead to backside wear of polyethylene and decreased implant longevity. If the bony resection is generous, the surgeon may even generate a gap too large to be filled by a spacer. The recommendation for tibial bone cut in Western patients is to reach the bottom of the valley in the deficient side (ie, the medial side in varus knee). We strongly advise against this. We normally resect 5 mm from the lateral side, and we do not have any problem having a concave surface on the medial side of the bone. This concave surface is normally drilled with multiple holes and filled with cement and screws (Fig. 141.29). Trying to reach the bottom of the deficient bone with your bone cut on the medial side will lead to significant bone loss on the lateral side, which might lead to the use of a thicker bone component, and the deeper cut will lead to osteoporotic bone, increasing the risk of tibial subsidence, especially in obese patients.

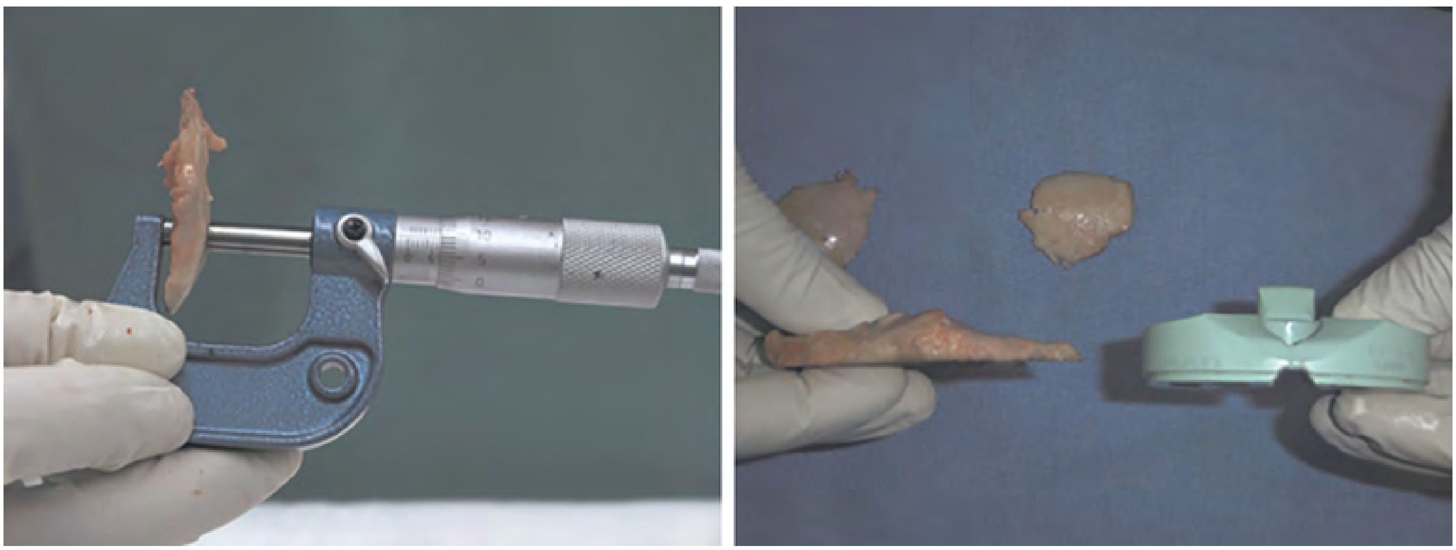

FIG141.27 Caliper measurements of the resected bone (left) along with a com..

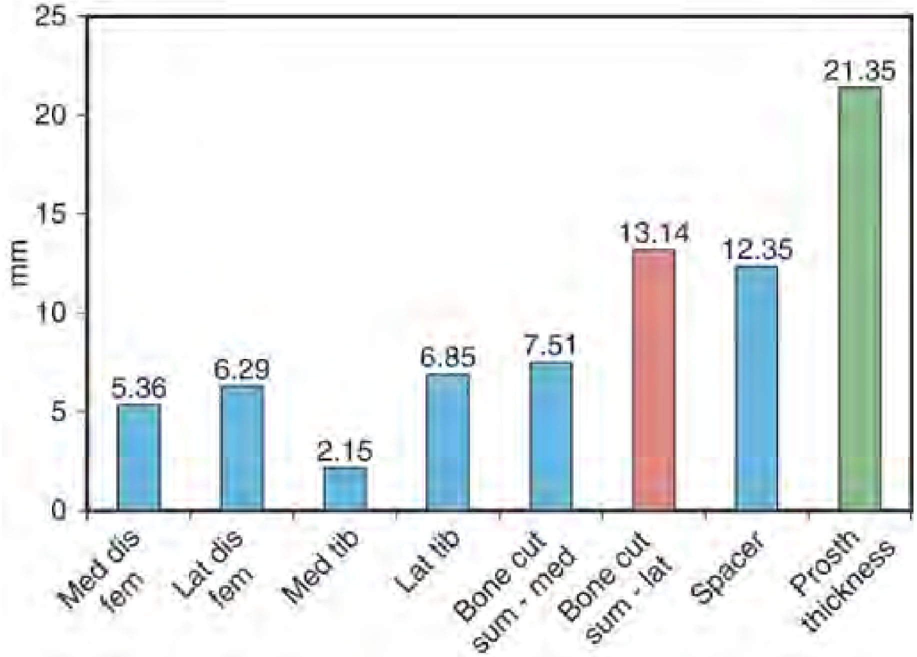

FIG141.28 Bar graph showing the thickness of our bone cuts compared with t…

FIG141.29 Drilling holes in the tibia and filling them with screws and cement …

In conclusion, it is advisable to take only 5 mm from the intact lateral condyle of the distal femur and 5 mm from the intact lateral tibial surface in a varus knee, even with mild deformity. It is quite easy for the surgeon to recut if after the release the gaps are still tight. However, in most cases, we found that 5 mm is adequate and normally the release will widen the gaps, especially after resecting the pathologic PCL.

After performing the bone cuts, we proceed to check for symmetry between flexion and extension gaps and both medial and lateral compartments. Most of the time we will require extensive release to achieve symmetry. A varus deformity is present in the overwhelming majority of our patients, with only 7% of patients presenting with a valgus deformity. This varus deformity can exceed 30 degrees in some cases. Thus our soft tissue release is primarily done on medial structures, with our registry data showing the performance of a medial collateral ligament (MCL) release on 68% of our patients. We normally release in increments, meaning we initially release so that we have a reasonable opening and then fine tune the release after placement of a trial component. The stages of medial release are conventionally described as follows:

1. Superficial MCL
2. Deep MCL
3. Pes anserinus.

With the superficial release, we normally start with anterior part of the MCL with the use of a curved osteotome. We try to release the superficial part of the MCL from the metaphysis of the tibia. We should stress that in our release we try to preserve the anterior attachment of the pes anserinus, and we slide the osteotome deeper than the pes anserinus attachment. Hence we try to stay directly on the bone. This is challenging in obese patients because often the MCL is not clear, so we normally stress to just stay on the bone. We avoid releasing the pes anserinus because its release can render the MCL unstable because the MCL will not be pushed to the metaphyseal area of the bone. The pes anserinus is a dynamic stabilizer for the medial compartment; even if it is tight it will stretch because the tendon is attached to the muscle and it will later stretch in a gradual fashion.

The second degree of release is carried out on the deep ligament. We start releasing approximately an inch from the articular surface of the tibia. The surgeon can normally feel with his or her digit which part of the ligament is tight and precisely follow it up and detach it from the bone. We normally like to keep the MCL attached to the soft tissue sleeve as in one block. Failure to do that will weaken the MCL, and the surgeon can have instability. The third degree of MCL release is incising pes anserinus itself, which we rarely do in spite of severe deformity. This is a last resort and is mistakenly performed in cases in which there was actually inadequate release of the MCL.

With regard to release in valgus deformity, which is rarer in our population, we follow Whiteside's recommendation, which normally considers whether the valgus sleeve is tight in flexion or extension. If it is tight in extension, the iliotibial band is released. If it is tight in flexion, the lateral collateral ligament is released.[50] The point that should be stressed is that in any gross deformity the soft tissue release is carried out in an incremental fashion, meaning that after we perform our cuts we try to do some release to see if the gap balances medially and laterally. The release is not finished until we resect all the bony osteophytes and resected the PCL, and the last stage of the release is performed on the trial component. This is key because we have found that balancing on the trial component is more accurate with the trial component when compared with blocks. To aid in balancing the soft tissues, we have used a device labeled a dynamic spacer, which consists of two plates with two springs between the two plates on either side (Fig. 141.30). The purpose of the springs is to apply constant pressure, and we have found it quite useful in monitoring the amount of release, especially with MCL release.

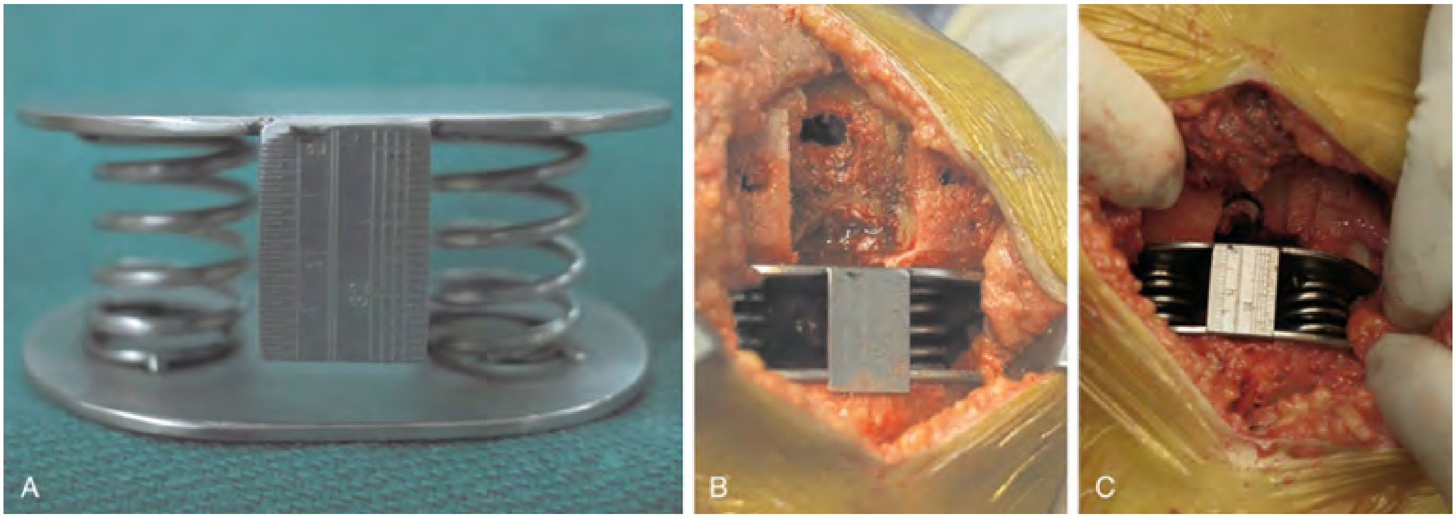

FIG141.30 A, Dynamic spacer. Use of the dynamic spacer to detect an unbala…

The intramedullary notch is then made using a special guiding block, after which a trial component is placed. We test the stability, both in midflexion and extension and gap symmetry at this stage. If we have symmetry in the medial and lateral compartments and the knee is stable, then we proceed with a regular posterior stabilizer. If we get an opening of more than 4 mm in midflexion with the trial components with a regular posterior stabilizer we make sure to have a backup revision system, namely the CCK, which we use in 5% of our primary TKAs. We would consider using it if there was any significant medial and lateral instability with the trial components before cementing. This would usually happen in knees with severe deformity that were initially unstable and then with extensive release the instability increased. Surgeons should always have a backup revision system at hand because sometimes the instability is not obvious until the bone cuts are finished. More recently we have started using the CPS polyethylene insert. As we described previously, this insert has a higher and wider spine that locks into the normal implant. The advantage of this insert is that we can lock the spacer into the regular primary plate to stabilize the knee in flexion. This has proven to be quite beneficial in Middle Eastern patients, especially after extensive release of the MCL, which can lead to instability in flexion. Now the CPS insert is giving mediolateral stability and functions as an internal splint until the MCL heals.

The advent of the CPS insert has addressed the issue of instability with opening of the joint more than 2 to 4 mm that was noticed after cementing. Previously we would accept this instability as the price to be paid to have balance in the collateral ligaments or revise the primary knee that we had already placed. The latter choice of revising the primary knee is an unfortunate choice that we have been forced to make because of unacceptable instability post cementing. This prolongs the exposure time as well as incuring significant cost and trauma for the patient. The great advantage of the CPS insert is that decision about its use can be made after cementing when there is significant instability and locks into the same tibial tray, thus avoiding the use of a revision system. The only requirement for the CPS insert is that the surgeon deepen the intercondylar notch using a small osteotome. We normally hold the polyethylene and slide it onto the femur to make sure it is not hitting the roof of the intercondylar notch. Unfortunately there are no long-term data on the CPS insert, and we caution surgeons about using it until clinical trials can assess its longevity. We therefore advocate its use only in instances of instability post cementing.

Patella: To Resurface or Not to Resurface?

To resurface or not to resurface a patella has been a very controversial issue. Our preference is not to resurface the patella. This is based on Middle Eastern and Asian patients tending to have smaller and thinner patellas.[25] In addition, the patients are going to kneel on their knees, and the patient may have accidental trauma while they kneel on the ground. Our concern is that resurfacing the patella may weaken it, which may lead to patellar fracture. Patellar fracture is a very serious complication after TKA, especially if the patella has been resurfaced. Such fracture may require an allograft, and safe allografts in our region are difficult to acquire. There is also some literature showing that patellar resurfacing does not improve the outcome of TKA.[10,11] Based on these factors, we do not resurface our patella and we only trim the osteophytes of the patella to make sure that it will not catch on the edge of the femoral component. We normally smooth the sharp edges of the patella using an oscillating saw to round all the corners. We resurface the patella only if the patella is concave and we could not perform a patelloplasty and cannot restore the normal shape. In such rare occasions, we have resurfaced the patella and in only 2% of our procedures have we resurfaced the patella.

Postoperative Care

We encourage an active multidisciplinary approach to postoperative care. All the health care professionals that are involved in postoperative care routinely participate in meetings to discuss postoperative protocols and ways to improve them. We found that that these regular meetings for our staff, which includes pain management nurses, floor nurses, physiotherapists, and physicians, are quite helpful in establishing proper protocols to care for our patients. Among many factors, pain management is the most challenging problem in achieving full flexion following TKA.[35] Providing ineffective pain relief during the early postoperative period (7 to 10 days) can be detrimental in achieving full flexion. Effective management of pain during the early postoperative period can also prevent the development of chronic pain in the future. A multimodal approach to pain management is important to control postoperative pain. Attacking the pain pathway in different sites includes the following:

1. Local anesthesia
2. Nonsteroidal antiinflammatory medication
3. Narcotic analgesics
4. Nonnarcotic analgesics
5. Nonclassical pain medication.

Local anesthesia that includes central neuronal blockade and epidural anesthesia provides effective anesthesia for both legs. This can provide prolonged pain management over a few days for postoperative pain. We have used peripheral nerve blocks, including femoral nerve blocks, especially in unilateral surgery. We also routinely use a local anesthetic infiltration before closure, consisting of 10 ml of 0.5% Bupivacaine. We also use the continuous infusion of local anesthetic intra-articularly using a catheter; we normally use the catheter for up to 3 days, after which it is removed. This has proven to be useful in patients who undergo unilateral TKR.

Nonsteroidal antiinflammatory medication is an important component of a multimodal approach to pain management. The choice is usually between cyclooxygenase (COX)-1 and COX-2 inhibitors, and we try to avoid it in patients with significant coronary heart disease. We normally prefer COX-2 inhibitors because we can also use our anticoagulant postoperatively. We have used an epidural catheter, which was kept in place for an average of 3 days postoperatively. We found this to be a good modality of pain control; however, it usually requires close monitoring on the floor. Naturally systemic narcotics delivered via parenteral or intramuscular routes are important for breakthrough pain or before physiotherapy. This will enable the physiotherapists to work harder on flexion for the patient. For oral narcotics, we normally use oxycodone on an as-needed basis.

Nonnarcotic analgesics include 1g of IV acetaminophen. It has been very effective for mild-to-moderate pain, without any sedation or respiratory depression. We have also used it orally on an as-needed basis. Nonclassic analgesics include anticonvulsant drugs, such as gabapentin and pregabalin. We normally start pregabalin 75 mg twice a day. There are studies supporting the effect of the anticonvulsants in preventing chronic pain.[12,16] We sometimes use antidepressant medication if we notice that our patients shows signs of postsurgical depression. On occasion we have used a short course of prednisone to prevent swelling and excessive pain. This has proven to be very effective, especially in patients who have generalized soft tissue swelling and those who wish to develop full flexion. We normally use oral prednisone 20 mg on a daily basis for 1 week. Studies have confirmed the effectiveness of steroids in controlling pain and improving recovery time postoperatively.[5,30]

The physiotherapy is quite aggressive in our patients to achieve full flexion. Preoperatively the physiotherapist evaluates the patient and documents range of motion and discusses with the patient the postoperative course. Those patients with good range of motion preoperatively and keen on achieving full flexion postoperatively are normally flagged to work with them aggressively postoperatively, and on some occasions, if the patient's general medical condition does not allow full flexion, we inform the patient that full flexion is not advisable for him or her because of either increased weight or a neurologic problem.

Postoperatively physiotherapy is started on day 1. It usually involves active ankle pumps and manual calf stretches and resisted plantarflexion and straight-leg raises. The patient is instructed how to do quadriceps isometric exercises and short arc quads. We normally do not use the continuous passive motion (CPM) machine, and we encourage the patient to do exercises on their own without the CPM machine.

On day 2, day 1 exercises are repeated. We start mobilization with a high frame walker. Two physiotherapists are normally required. We encourage the patient to ambulate with the walker.

Day 3 to 4 the patient is instructed to repeat exercises as before, we start mobilization with a regular frame, and we teach the patient the importance of deep flexion activity.

Day 5 to 7 we progress to ambulation with a lower frame walker for longer distances, and we teach the patient exercises he or she can perform independently and also encourage family participation. We also start stair training and investigating home facilities, and we get the family involved in discharge planning.

After 2 weeks, physiotherapy involves the stationary bicycle, quadriceps strengthening with light ankle weights, hamstrings and gastrocnemius stretches, and balance and proprioceptive exercises. Patients who achieve full flexion normally achieve it within the first month after surgery, and we try to encourage the patient to walk with a cane and gradually return to his or her functional activity. Our experience shows that patients who achieve full flexion normally achieve it in the first 6 weeks (Fig. 141.31). If they do not achieve it within this time, it is quite difficult to achieve it later. After 1 month, we allow the patient to kneel on his knee in full flexion with the calves touching the hamstrings, and we encourage him to do water-based exercises if the wound is dry. We have organized a small group for our postoperative patients; this group includes five patients per group, and the exercises are carried out for this group together. We have found this to be quite helpful and the patients tend to encourage each other. However, we must stress that all these patients should be of similar body mass indices, objectives, and age, to the greatest degree possible.

FIG141.31 Full flexion in patient 2 to 4 weeks postoperatively. (Courtesy Dr. Sam...

Conclusion

Patients who present for TKA in the Middle East have special needs, and the anatomy of the knee has some unique features when compared with Western patients. These features are not limited to Middle Eastern patients but also found in the Asian population at large. This will dictate some considerations when TKA is performed in Middle Eastern patients. The surgeon should be aware that special considerations should be taken into account regarding the implant. Some implants may not be appropriate because of the anatomy and pathologic features of Middle Eastern and Asian patients. For example, cruciate-retaining implants may not work in some of our patients. In addition, the severity of the disease will force the surgeon to perform simultaneous bilateral TKA more often than in Western populations. The activities of daily living force the patient into activities involving deep flexion. We believe that full flexion can be achieved to meet the specific needs of the patients. The subvastus approach and anterior quadriceps release have worked well for us and enabled us to achieve better flexion than reported in most of the Western literature. In spite of all these challenges, we have managed to achieve results that meet the patient’s expectations in our region. We still believe that industry has to give more consideration to specific needs of Middle Eastern patients so that they can produce more compatible designs for our patients.

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