CURRENT CONCEPTS REVIEW

Narrative review of the valgus knee in primary total joint arthroplasty

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Abstract

The valgus knee is less common than the neutral or varus aligned knees in primary total knee arthroplasty (TKA). TKA is technically more challenging in the valgus knee because of the relative difficulty of restoring the joint line, correcting limb alignment, ensuring stability and correcting patellofemoral tracking. Consequently, TKA outcomes are poorer in the valgus knee. The valgus deformity may be intra- or extra-articular or a combination of both, with bony and soft tissue changes resulting in alteration of the rotational profile of the lower limb. Bony changes in the femur include hypoplasia of the distal femur lateral condyle and erosion of the posterior aspect of the lateral condyle. Bony changes in the tibia include remodelling of the lateral tibia plateau and metaphyseal bone. Soft tissue structures on the lateral aspect of the knee may be contracted or tightened with attenuation of the medial stabilising structures. These features contribute to a change in the rotational profile of the knee resulting in external rotation of the tibia and lateral subluxation of the patella with maltracking. Clinical examination should be thorough in both standing and supine positions and must the include the foot and ankle as hindfoot alignment affects the mechanical axis of the weight-bearing lower limb. Neurovascular assessment of the limb should document peroneal nerve integrity as this nerve is at risk of damage at the time of deformity correction. Radiological assessment should, ideally, include long limb weight-bearing views in multiple planes. Computer tomography scanning may be appropriate in cases of severe bony deformities or poorly appreciated anatomical landmarks on standard radiographs. This review delves into the various classification systems for valgus knees and finally, focuses on surgical approaches, appropriate implant choices and technological advancements in the management of the valgus knee. A clear understanding of the pathoanotomy of the valgus knee together with a thorough clinical assessment and appropriate use of technology should help improve outcomes of TKA in the valgus knee.

Level of evidence: Level 5

Keywords: knee, arthroplasty, valgus, replacement, technique

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Introduction

Total knee arthroplasty (TKA) is one of the most successful orthopaedic surgery procedures performed with reported survivability of 82% over 25 years using available pooled registry data.[1] TKA is performed with the aim of providing long-term relief of pain and restoration of function.[1] The technical goals of the total knee replacement include restoring the joint line, correcting limb alignment, ensuring stability of the joint, maintaining adequate range of motion, and ensuring correct patellofemoral tracking while utilising adequate fixation techniques for the inserted implants.[2] Valgus deformity in the knee is defined as an angle of more than 10° between the anatomical axis of the tibia and femur in the coronal plane.[2,3] Achieving the aforementioned goals in a knee with a valgus deformity continues to be a challenge.[4,5] Knees with excessive preoperative valgus > 11° not corrected to neutral alignment (< 2.5° of valgus or > 7.4° of valgus) have a higher failure rate compared to knees with excessive valgus that are corrected to neutral alignment (3.3% compared to 1.9%). Furthermore, TKA in preoperative valgus malalignment is associated with twice the risk of failure of TKA in varus malalignment.[6,7] Inflammatory arthritis, post-traumatic arthritis, primary osteoarthritis, metabolic bone disease or over-correction with high tibial osteotomy are known to be associated with a valgus knee deformity.[2-4] Osteoarthritis remains the most common cause of a valgus knee deformity.[8] There are both osseous contributions, from the distal femur and proximal tibia, as well as soft tissue contributions to the valgus deformity.[9] When addressing the valgus knee deformity, the orthopaedic surgeon needs to be cognisant of the various pathoanatomic features of the deformity that need to be addressed and taken into consideration during the planning and execution of the TKA.[8] These include the surgical exposure, bone cuts, level of implant constraint, gap balancing, preserving the peroneal nerve, balancing the patellofemoral joint and the soft tissue closure.[8,10]

Epidemiology

Well over a million primary TKA procedures are currently performed annually worldwide and this number is predicted to increase sharply over the next decade.[1,11,12] More than 100 000 TKA are performed in the United Kingdom annually, with the United States of America (USA) leading national joint registries with 911 000 procedures recorded in 2017.[11,13] This is projected to increase to 935 000 procedures by 2030.[12] Approximately 10–20% of patients requiring TKA have a valgus deformity.[2,5,14,15]

Pathoanatomy

Various pathoanatomic features of the valgus knee deformity have been described, and a thorough understanding of the clinical and pathoanatomic features of the valgus knee is of paramount importance in guiding the technical aspects of the TKA and achieving good outcomes.[14] The valgus deformity may be intra- or extra-articular, arising from one or a combination of anatomical features involving bony changes of the tibia or femur and the surrounding soft tissues.[2,14]

Bony changes in the femur include:

- Hypoplasia of the distal femur lateral condyle
- Lateral posterior condyle erosion
- Metaphyseal remodelling
- Unusual proximal neck-shaft angles

Bony changes in the tibia include:

- Remodelling of the lateral plateau
- Metaphyseal bone[2,5,14]

The soft tissue elements consist of contractures and tightening of the lateral collateral ligament, posterolateral capsule, popliteus tendon, iliotibial band, hamstring muscles (long head of biceps femoris) and lateral head of the gastrocnemius.[2,5,16] It has been proposed that the posterior cruciate ligament (PCL) contributes to the valgus deformity, but it is not universally accepted that it maintains the deformity.[5] With tightening of the lateral structures there is attenuation of the medial stabilising structures of the knee, and it has been reported that there may be medial collateral ligament deficiency in 17–20% of valgus knees.[5,14] The described pathoanatomic features not only contribute to the valgus deformity of the knee but result in external rotation of the tibia and lateral subluxation of the patella with patellofemoral maltracking.[5,8,16] The pathoanatomy contributes to the difficulties encountered in balancing of the soft tissue structures, once mechanical limb alignment is corrected.[5,8,16]

Clinical examination

Thorough preoperative clinical and radiological examination while keeping in mind the abovementioned pathoanatomic features is important in the planning for correction of the valgus deformity. Examination should include assessment of gait, specifically identifying dynamic instabilities.[5,17] The lower limb alignment in standing and supine positions needs to be analysed, as well as the correctability of the deformity with focus on the integrity of the stabilising structures.[5,8] Differentiating whether a valgus deformity is fixed or correctable, and whether the medial stabilising structures are intact, can potentially influence the extent of soft tissue releases and the level of prosthesis constraint required.[5] Assessment of active and passive knee range of motion and any sagittal deformities, such as fixed flexion deformity or recurvatum, are important to note preoperatively.[5,8] The patellofemoral joint should not be neglected, with evaluation of the extensor mechanism and patellofemoral tracking.[5] Examination of the entire lower limb including the foot and ankle is important as the hind foot affects the mechanical axis of the lower limb, and coronal hindfoot deformity may affect knee mechanics after TKA (*Figure 1*).[18] Patients with genu valgus predominantly have associated hind foot varus,

Figure 1. Severe valgus deformity of left knee (a), with pes planus of right foot (b) and left foot (c)

but may have hind foot valgus.[18] It has been suggested that the hindfoot deformity should be addressed prior to TKA to minimise abnormal stress on the implant; however, other authors feel that hind foot alignment does improve post TKA but residual problems should be noted and addressed if the correction is inadequate.[19] Patients with planovalgus foot deformity walk with a high abduction moment leading to stretching of the medial collateral ligament post surgery and therefore may require insoles or surgery to address the foot and ankle deformity.[17] Thorough neurovascular examination of the lower limb should not be neglected due to the risk of injury of the neurovascular structures during the deformity correction, especially the peroneal nerve.[16]

Radiological examination

Radiographs should, ideally, include long limb standing views to assist in identifying the overall limb alignment, with mechanical axis deviation, and the level of the deformity.[4,8] It is important to determine whether the deformity is intra-articular or extra-articular, and the degree of deformity, as this will influence the surgical planning regarding concomitant osteotomies as well as intra-articular correction addressed with soft tissue balancing.[17] Long limb X-rays help in identifying the mechanical and anatomical axis of the femur and guide the correct insertion of the intramedullary rod and the correct valgus cutting angle of the distal femur to restore mechanical alignment in conventional jig-based TKA.[20] Weightbearing anterior posterior, lateral and merchant views radiographs provide the required information regarding bony deformities, including patency of medullary canals needed for intramedullary referencing.[4,8,17] Some authors have proposed CT evaluation as part of the radiological work-up to plan the femoral cuts due to the severe bony deformities that make intraoperative identification of anatomical landmarks difficult.

Classification

Numerous classifications have been proposed over the years, trying to quantify the severity of valgus deformity and taking into consideration features that may need to be addressed when approaching the valgus knee deformity.

Krakow classification (1991)

The Krakow classification classifies the deformity within three categories based on the integrity of the medial soft tissues and history of previous surgery, as follows:[21]

- Type I deformity; the medial collateral ligament is intact
- Type II deformity; there is insufficiency of the MCL with a positive valgus stress test
- Type III deformity; a valgus deformity secondary to a high tibial osteotomy

SOO classification (2003) (Societe d'Orthopedie de l'Ouest – Western France Orthopedics Society)

There are four types of valgus knees that increase in surgical difficulty:[22]

- Type I does not have medial laxity and can be completely reduced
- Type II does not have medial laxity and may be partially or completely reduced but requires lateral soft tissue releases
- Type III is reducible but there is medial laxity that may require intervention
- Type IV is irreducible with medial laxity and combines problems of types II and III

Ranawat classification (2005)

The Ranawat classification combines previous classifications with the addition of the magnitude of the deformity:[2]

- Type I deformity has less than 10° of valgus with minimal attenuation of the medial soft tissue stabilising structures
- Type II deformity has more than 10° of valgus deformity with elongation of the medial soft tissue stabilising structures
- Type III has severe deformity of more than 20° valgus, with incompetent medial soft tissue stabilising structures

Mullaji classification (2014)

Mullaji et al. suggested that the previous classifications were designed for patients from more developed nations, and did not take into consideration patients arising from areas of more restrictive healthcare access with more severe deformities. They proposed a classification that included six types and incorporated sagittal deformity as well as extra-articular deformity:[23]

- Type 1 is a reducible valgus deformity
- Type 2 is an irreducible valgus deformity
- Type 3 is a valgus deformity associated with recurvatum
- Type 4 is a valgus deformity associated with a flexion contracture
- Type 5 is valgus deformity with insufficiency of the medial collateral ligament
- Type 6 is a valgus deformity with an extra-articular component

Yang classification (2021)

Yang et al. proposed a classification for valgus deformity based on radiographic analysis using X-ray and computed tomography (CT) to assess deformity. Valgus deformities could be classified into five subtypes according to whether the deformity involves the femur or the tibia and whether the deformity is intra-articular or extra-articular. The subtypes included in the femoral deformity group are the distal lateral femoral condyle (F1a), both distal and posterior lateral femoral condyle (F1b), and extra-articular deformity involving the supracondylar region of the femur (F2). The subtypes involving the tibia include intra-articular deformity involving the tibial plateau (T1), and extra-articular deformity involving the metaphysis (T2).[14] It should be noted this classification does not include assessment of the soft tissue structures.[14]

Surgical approach

Medial approach

The medial parapatellar approach has been well described and reported as the standard approach in both valgus and varus knees, despite the main pathology being on the lateral aspect in the valgus knee deformity.[3,8] The medial parapatellar approach allows sufficient exposure and access to the posterolateral corner to release tight structures in the less severe valgus deformity. However, it may be difficult to reach this area in more severe deformity.[3,4,8] If there is difficulty reaching the posterolateral corner, a tibial tuberosity osteotomy may facilitate exposure.[4] There needs to be caution with the medial collateral ligament (MCL) during this approach as detachment of the MCL needs to be avoided, and any medial release should be limited to overhanging osteophytes.[4] It has been reported that there may be easier dislocation of the patella with this approach due to the combination of the lateralised tibial tuberosity and valgus deformity, but a lateral patella retinaculum release may be required after deformity correction.[3,4]

Lateral approach

Keblish initially described an anterolateral approach for valgus knees in 1991, with a long incision along the lateral border of the quadriceps, leaving 10 mm of the lateral retinaculum and dislocating the patella medially.[24] The advantages of the lateral approach include improved visualisation and direct access to address the tight lateral structures while protecting the medial knee structures, as well as protection of the medial vascularity of the patella if a lateral retinaculum release is needed.[3,4,8] It has been suggested that, due to these factors, soft tissue balancing is easier to achieve and there is less requirement for a constrained prosthesis.[15] It should be noted that the lateral approach does not offer as much visibility of the medial and central aspects of the joint, and there is difficulty with patella eversion.[3,4] To increase the visibility, an osteotomy of the tibial tubercle may be required, which has its own associated complications as well as increasing surgical time.[3,25] A further potential complication of this approach is insufficient soft tissue for adequate wound closure after deformity correction.[3,4] To overcome the difficulty with soft tissue closure, approximation of the infrapatellar fat pad to the patella tendon may assist, or releasing the vastus lateralis from the rectus femoris followed by suturing them together in a staggered manner.[4] Even though there are disadvantages to the medial approach, the lateral approach is still considered an alternate approach.[8] The lateral approach is more challenging and requires a high level of technical familiarity.[15]

Intraoperative steps

Bone resection

It is well known that optimal component alignment is critical for the long-term success of TKA, as failure to achieve correct alignment can lead to instability, increased component wear, increased loosening, reduced range of motion, and pain.[26] Although new alignment concepts including kinematic (with multiple variations) and functional alignment have come to the fore, mechanical alignment as described by Insall remains the gold standard for TKA, particularly in the valgus knee deformity (*Figure 2*).[27,28]

The current consensus when attempting to restore the mechanical alignment is to aim for mechanical hip-knee-ankle (HKA) axis of within 3° of neutral.[29] Planning of the correct distal femoral and tibial cuts will assist in restoring the mechanical alignment and stability of the knee. In order to adequately restore the mechanical alignment of the valgus deformity, it has been suggested that the typical distal femur cut of 5–7°of valgus be reduced to 3° of valgus to avoid under-correction of the deformity.[2,4,8] Resection from the lateral distal femoral condyle should be kept to a minimum of 1–2 mm, or in severe deformity, use of metal augments should be considered.[4] More than 10 mm of bone resection from the medial condyle should be avoided.[4]

The anatomical reference points proposed to guide placement of the cutting jigs include the PCL, the anatomical transepicondylar axis (TEA), the surgical TEA, the anteroposterior (AP) axis, the femoral transverse axis and the tibial shaft axis.[30,31] The anteroposterior (AP) axis may be used to determine the correct rotation of the femoral component in the valgus knee with a hypoplastic lateral femoral condyle.[32] However, the greatest interindividual variability has been reported for the AP axis, as it can be difficult to identify with severe trochlear dysplasia.[4,30] The epicondylar axis has been reported to be difficult to determine intraoperatively.[3] The use of the posterior femoral condylar axis, if there is significant lateral femoral hypoplasia, runs the risk of incorrectly resecting an excessive amount of bone from the posterior aspect of the lateral condyle.[3] There should be a minimal amount of bone resected from the lateral femoral condyle due to the lateral femoral condyle deficiency; this will assist in the correct joint line restoration.[33]

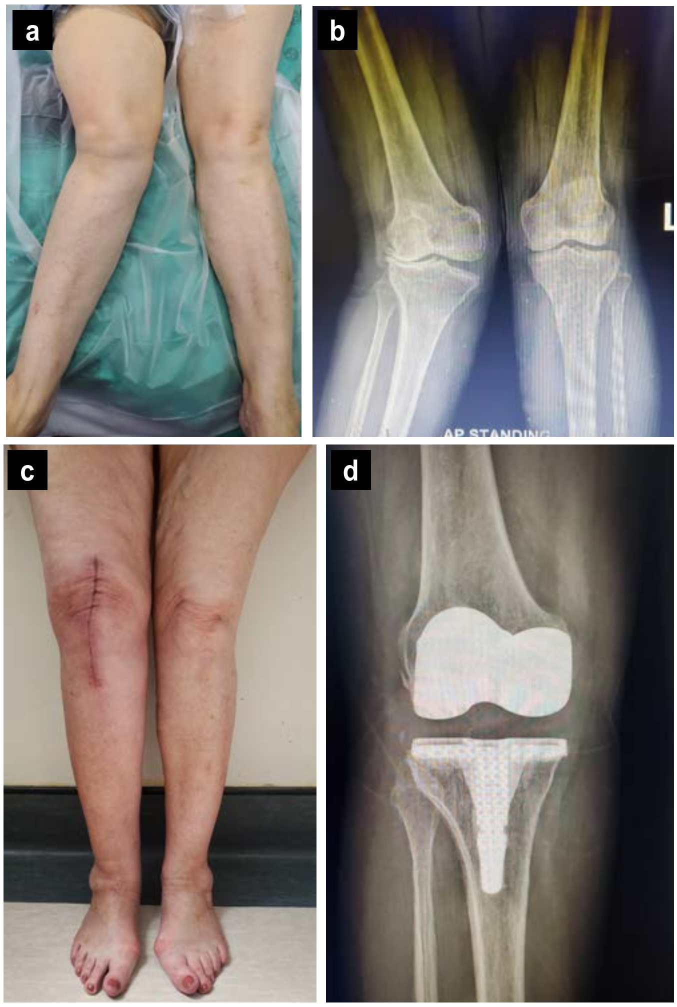

Figure 2. Clinical preoperative picture of severe valgus deformity (a) and standing AP X-rays (b). Clinical postoperative X-rays of corrected valgus deformity of same patient (c) and standing postoperative X-ray (d). The procedure was performed with a series of lateral soft tissue releases to restore mechanical alignment and joint stability.

Femoral component rotation affects the alignment in flexion and flexion instability.[30] Excessive inappropriate resection of bone may place the femoral component into internal rotation, affecting patellofemoral joint biomechanics.[3] The amount of combined internal rotation of the components correlates to the severity of the abnormal patellofemoral maltracking from mild rotation (1–4°) resulting in lateral tracking and tilting, to moderate rotation (5–8°) resulting in patella subluxation, and severe rotation (7–17°) resulting in patella dislocation and component failure.[34]

When trying to restore mechanical alignment, the tibial cut should be perpendicular to the mechanical axis of the tibia; however, the tibial resection should take into account any extra-articular deformity if present.[2,17,26] Before performing the resection, all the osteophytes should be removed, especially on the tighter lateral side of the tibia.[4] There should only be 6–8 mm of bone resected from the less affected medial compartment.[4]

Soft tissue balancing

There have been many different soft tissue release techniques described, yet no consensus regarding the sequence in which the structures about the knee should be released.[3,8,16] The structures that have been most often included in releases include the iliotibial band (ITB), posterolateral capsule (PLC), lateral collateral ligament (LCL), popliteal tendon, and the lateral head of the gastrocnemius muscle.[3] It has been shown that the extent of soft tissue releases needed are directly related to the severity of the valgus deformity.[16] However, there has been a move towards the least possible amount of lateral release required because extensive releases have resulted in instability, loosening and the need for reoperations.[8] It must be kept in mind that inappropriate lateral release results in residual valgus deformity, unequal flexion and extension gaps and possible patellofemoral alignment problems.[8] A few described soft tissue release techniques will be summarised; however, due to the nature of this review not all the specific details of each release technique will be included.

Krakow et al. (1991) described a release technique that begins by releasing the ITB and LCL subperiosteally initially followed by the PLC, popliteus and finally the lateral head of the gastrocnemius.[21] If the release of the lateral structures was combined with PCL sacrifice, a 9° correction could be achieved. The LCL is the primary stabiliser of the lateral side of the knee joint; therefore, if secondary stabilisers are released prior to the LCL release the correction may not be adequate.[3]

Whiteside (1999) described sequential soft tissue releases of the ITB, popliteus, LCL and lateral head of the gastrocnemius based on the tightness of the extension and flexion gaps.[35] It was noted that only in situations of extreme lateral tightness did the popliteus need to be released.[35] The ITB was only released when there was tightness in extension.[35] Tightness in both flexion and extension was addressed by releasing LCL and popliteus.[35]

Ranawat et al. (2005) described the 'inside-out' technique, with multiple small stab incisions aimed at releasing ITB and LCL, while preserving popliteus.[2] All peripheral osteophytes are removed and the PCL is released, followed by the posterior capsule and the PLC with sparing of the popliteus. The tight ITB may be released with a 'pie-crusting' technique in order to preserve continuity while lengthening.[2] Progression to the flexion gap balancing should only be done once the extension gap is balanced, as the flexion gap is balanced with bone cuts with this sequence of releases.[2]

Aglietti et al. (2007) described performing an 'inside-out' release using a pie crusting technique to release the lateral soft tissue structures including the LCL.[36] The PCL is always excised, and a laminar spreader instrument is used to assess symmetry of the extension gap.[36] Multiple small inside-out stab incisions are used to release the lateral structures, starting from the PLC, progressing anteriorly to include the LCL and ITB.[36] Usually no releases are needed for the flexion gap as the correct external rotation of the femoral component compensates for the minimal flexion laxity.[36]

Boettner et al. described a standardised soft tissue release, with routine release of ITB, PLC, LCL and the anterior lateral ligament in all patients with valgus deformities up to 25°.[37] The popliteus is considered a dynamic stabiliser and was not released during this technique.[37] Caution should be exercised in adopting a standard recipe for ligament release in every patient as this often results in in excessive use of constrained components.[16]

If releasing the lateral soft tissue structures does not achieve adequately balanced flexion and extension gaps, then the medial soft tissue structures can be addressed.[3] Advancement of the MCL off the tibial side, and MCL mid-substance imbrication, have been described by various authors to address the laxity of the medial side of the knee before increasing component restraint.[3]

Surgical correction of a valgus knee deformity with extra-articular components may require a corrective osteotomy.[14] A lateral epicondylar sliding osteotomy may be used to transform an extra-articular deformity to a partially defected lateral femoral condyle with a balanced mediolateral gap.[14]

Soft tissue releases are not isolated to the balance and stability of the tibiofemoral joint, but may include lateral retinacular release to ensure correct patella tracking and avoid patella tilt.[16] Patella tracking should be assessed without an inflated tourniquet, and if the components are believed to be correctly positioned, pie-crusting of the lateral retinaculum may be performed instead of a full longitudinal release.[2] One should be wary of the possible associated complications of patella retinacular release such as bleeding, patella devascularisation and wound complications.[16]

Implant choices

Implant selection should be based on preoperative planning, taking into consideration the clinical and radiographical parameters but the final decision needs to be made intraoperatively after the bone cuts and soft tissue balancing.[5] The goal is to use the least constrained prosthesis that provides adequate stability in a well-balanced and aligned knee.[3,5] Both cruciate-retaining (CR) and cruciate-sacrificing implants have been utilised with adequate results.[8] The temptation to automatically progress to a highly constrained prosthesis to compensate for poorly balanced soft tissues should be avoided.[3] Due to the bony deformities, such as bone deficiency with the hypoplastic femoral condyle, component augments may need to be considered for adequate prosthesis placement.[3,17]

Some authors have advocated the use of CR components; however, it must be kept in mind that it is more difficult to obtain deformity correction and soft tissue balancing with a CR implant, since the PCL has a stabilising function and may contribute to the deformity.[5,36] With proper bony resection and correct soft tissue balancing, CR implants in type 1 valgus knees function adequately.[8] McAuley et al. (2008) found that in some variations of valgus deformities the use of CR implants has improved longevity when the LCL and/or popliteus tendon are intact; however, the risk of revision is increased when both the LCL and popliteus are released resulting in more mediolateral laxity.[38] The advantage of using CR implants is the preservation of condylar bone in the event of revision surgery.[8]

Use of the posterior stabilised (PS) implant has been suggested, such as when the coronal deformity is mild (< 10°) with inadequate MCL tension.[2,8] One of the advantages in using the PS design in the corrected valgus deformity knee is the ability to lateralise the tibia and femur components allowing better patella tracking and negating the need for lateral patella retinaculum release.[2] The post-cam mechanism and joint surface conformity in the PS implant increase the component stability, with some degree of posterior stability as well as stability against posteromedial, posterolateral, straight medial or straight lateral translation.[2,3] It will not protect against residual medial laxity.[3] In more severe deformity, the mechanical stresses placed on the polyethylene cam may result in increased implant wear and premature loosening.[8] This risk of early failure of the polyethylene cam can be mitigated by constrained condylar implants with a larger cam and stems that distribute stresses along metaphyseal and diaphyseal bone.[8] The disadvantage of constrained implants is the increased bone loss with the larger femoral box and the invasive stems.[8]

Due to the poor outcomes from balancing the soft tissues in the valgus knee, some authors have suggested the routine use of constrained prostheses.[2] Indications for the use of a constrained hinged prosthesis include, among others, severe valgus deformity (> 20°) with relevant soft tissue release and bone loss, gross flexion- and extension-gap imbalance, and hyperlaxity.[39] Unfortunately, the improved stability provided by constrained hinged implants do have limitations including the necessity for longer stems, cementing of stems, the risk of premature implant loosening and early failure of the implant.[8] Constrained hinged implants used in correction of valgus deformity have shown a survival rate of 79% at 13 years follow-up, although this does depend on the age of the patient in whom the implant was inserted.[40]

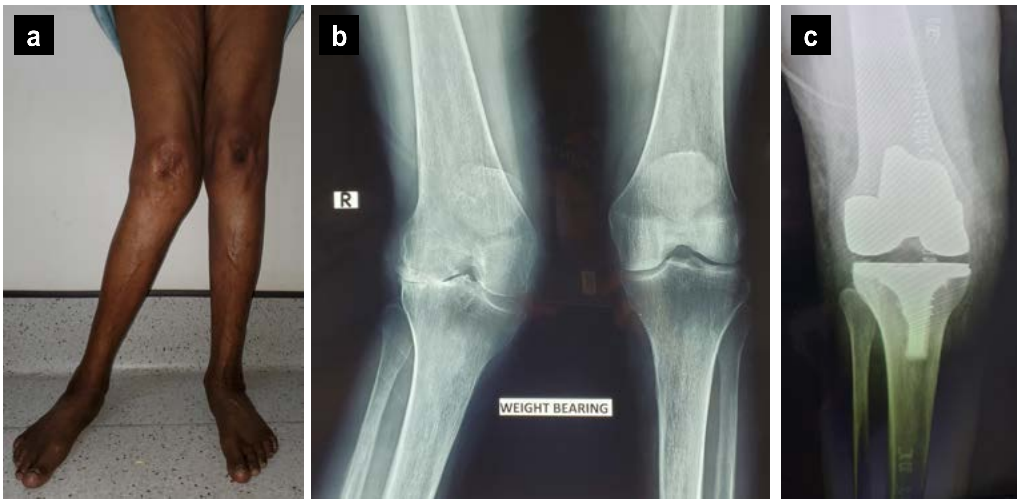

Figure 3. Clinical picture of severe valgus deformity (a) with weight-bearing AP X-rays (b); postoperative X-ray of total knee arthroplasty using computer navigation to achieve correction of the deformity (c)

Technology in the valgus knee

The use of computer-assisted surgical (CAS) navigation and robotic-assisted surgery in TKA is growing.[41,42] There is better control of component positioning and alignment in CAS and robotic-assisted TKA compared to conventional jig TKA. (*Figure 3*) [42,43] Improved accuracy in alignment and component placement has resulted in reduced outliers when using this technology but significant difference in long-term outcomes or revision rates is yet to be demonstrated.[42,44] These systems have advantages in reducing blood loss and emboli phenomena.[42] Complex deformities including severe valgus with sagittal plane deformities as well as extra-articular deformities lend themselves to planning and correction using robotic systems.[10,26] CAS navigation has been shown to improve certain aspects of the procedure, as shown by Mullaji et al. (2010) using navigation to perform lateral femoral epicondylar osteotomy for precise lengthening of the tight lateral structures and to correct TKR alignment in the arthritic knee with extra-articular deformities.[45,46] The routine use of these technologies in addressing the valgus knee deformity has not been widely adopted; however, knowing that they are available and the proposed benefits as well as drawbacks are important for the practicing orthopaedic surgeon.[4,10]

New concepts in classification of knee alignment

Hirschmann et al. (2019) introduced a novel classification for phenotyping of the coronal alignment of the native knee that highlighted the importance of the orientation of the joint line over and above overall limb alignment.[47] They pointed out limitations in the current system of classifying the overall alignment as either valgus, varus or neutral and suggested that the phenotypic classification would be useful in an individualised TKA approach.[47] Macdessi et al. (2021) proposed a new classification system for the coronal plane alignment of the knee (CPAK) based on the HKA angle and taking cognisance of the joint line obliquity.[48] They proposed nine different types. They showed that knee types that fall into the traditional neutral and varus alignment (type I, type II CPAK) benefitted the most from kinematic alignment when optimisation of soft tissues was prioritised compared to mechanical alignment.[48]

The increasing recognition of the benefits of a more personalised approach to alignment of TKA that is made possible by enabling technology such as CAS and robotics has presented us with a confusing array of possibilities without defining safe limits. Schelker et al. (2022) in their systematic review of 'safe zones' in coronal alignment concluded that use of ± 3° based on mechanical alignment is no longer applicable to modern TKA based on the current literature.[49] However, there was lack of data on the outcome of more extreme alignments, more so for the valgus knee.[49] This appears to be a common trend when comparing outcomes of more personalised approaches such as kinematic alignment to traditional mechanical alignment in TKA, with numerous studies excluding patients with more severe valgus deformities.[50]

Complications

There have been numerous complications reported after correcting valgus knee deformity in total joint arthroplasty relating to the severity of the deformity and the difficulty in correctly positioning components while trying to achieve the correct alignment of the limb. Complications include residual tibiofemoral instability, recurrent valgus deformity, patellar stress fractures, patellar osteonecrosis, patellofemoral maltracking, loss of postoperative range of motion, wound breakdown and peroneal nerve injury.[3,4] The peroneal nerve may sustain direct injury intraoperatively during the soft tissue releases or indirectly via traction or ischaemic injury associated with correcting the valgus deformity.[4,8] If peroneal nerve palsy is identified postoperatively, positioning the knee in slight flexion and releasing any compressive dressings may assist.[8] If a tibial tuberosity osteotomy is required for adequate exposure, there is the additional risk of non-union and extensor mechanism problems.[8]

Conclusion

Approaching the valgus knee deformity in arthroplasty surgery continues to challenge orthopaedic surgeons. Over the years there has been a plethora of literature published regarding the many surgical techniques utilised with the common goal of improving the outcomes and preventing complications. This includes surgical approaches, bony resections, soft tissue releases, component placement and the types of components. Having a thorough understanding of the pathoanatomy of the valgus knee deformity and the unique problems they pose, as well as knowledge of the various options available to counter those problems, will empower the orthopaedic surgeon to achieve the best possible outcomes when addressing the valgus knee in total joint arthroplasty.

Ethics statement

The authors declare that this submission is in accordance with the principles laid down by the Responsible Research Publication Position Statements as developed at the 2nd World Conference on Research Integrity in Singapore, 2010.

Declaration

The authors declare authorship of this article and that they have followed sound scientific research practice. This research is original and does not transgress plagiarism policies.

Author contributions

RPA: study conceptualisation, first draft preparation, manuscript preparation, manuscript revision

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