Indian Journal of Orthopaedics Surgery 2023;9(4):211–216

Content available at: https://www.ipinnovative.com/open-access-journals

Indian Journal of Orthopaedics Surgery

Journal homepage: https://www.ijos.co.in/

Review Article

Total knee arthroplasty, different alignment and balance methods- A review

Nagesh Sherikar[1], Nitin Rawal[2], Mahesh Gowda[1], Rakshith Chakravarthy H Y[1*]

[1]*Dept. of Orthopaedics, MVJ Medical College and Research Hospital, Bangalore, Karnataka, India*
[2]*Dept. of Orthopaedics, SGT Medical College, Gurugram, Haryana, India*

ARTICLE INFO

Article history:
Received 23-07-2023
Accepted 08-09-2023
Available online 07-12-2023

Keywords:
TKA
Alignment
Balancing
Review
Kinematics

ABSTRACT

The two most frequent techniques used to implant a total knee replacement (TKR) are measured resection and gap balancing. Both methods have been around for a while and are currently in widespread usage, and both have shown to be effective in the real world. Plus, new technologies have evolved in the recent past to help surgeons achieve soft tissue balance and limb alignment.

Proper alignment of a knee replacement is crucial to its effective functioning. It has to be in the right axial and rotational planes for this to work. Patellofemoral instability and early wear can be caused by improper alignment, as can loosening of the prosthesis. Altering the prosthesis's orientation might potentially affect the tension of the surrounding soft tissues.

We have extensively reviewed 50 studies (Level 1- Level 4) published in many prestigious journals by searching through platforms like PUBMED, MEDLINE and EMBASE databases. In this research, we have attempted to document the relationship between alignment and the equilibrium of soft tissues and to summarize the present state of our understanding of this connection.

1. Mechanical Axis

The mechanical axis of the legs is the line between the middle of the femoral head and the ankle joint.[1] Drawing lines over bone intramedullary canals shows the femoral and tibial axes. The distal femoral joint should be 9 degrees valgus and the tibiofemoral joint 3 degrees varus relative to the body's midline. Correctly positioned TKAs produce a joint line perpendicular to the mechanical axis. This distributes force uniformly throughout the component's medial and lateral surfaces. A mechanical axis enabled this task.

Insall[2] pioneered a complete knee arthroplasty procedure that is now globally accepted. Healthy knees have a nine-degree femur valgus and a three-degree tibia varus. Perpendicular incisions in the femur and tibia are made to align the limb mechanically. This facilitates mechanical alignment. Both cuts are perpendicular to the machine's longitudinal axis. The tibia is sliced at 90 degrees to its anatomic axis and the femur at 4–6% valgus to realign the mechanical axis via the knee joint.[2] This treatment aligns the mechanical axis across the knee joint. This operation moves the mechanical axis to the knee center. After anatomic alignment—cutting the tibia at three varus points—Insall's implant would fail. The implant would fail due to medial joint line stress. The Insall hypothesis supported this strategy empirically. Green et al.[3] showed that varus tibial alignment increased anteromedial and posteromedial tibial surface stresses. Study found this. Green et al. discovered this.

* *Corresponding author*.
E-mail address: rakshu241@gmail.com (R. Chakravarthy H Y).

https://doi.org/10.18231/j.ijos.2023.041
2395-1354/© 2023 Author(s), Published by Innovative Publication.

Long-term TKA effectiveness depends on limb placement.[4–6] Postoperative varus limb alignment is linked to higher total knee replacement failure rates than normal alignment. Compared to normal alignment. Ritter et al.[7] found that varus alignment caused 27 of 38 (71%) unsuccessful tibial fractures in repeated posterior cruciate condylar TKAs. 38 patients yielded this result. Aglietti et al. found radiolucent lines in tibial components with a varus tilt of more than 2 degrees.[8] The best tibial component repair required a 90-degree tibia incision. Berend and colleagues found that tibial component alignment more than 3.0 degrees of varus and whole limb alignment less valgus increased the likelihood of failure. Collier and colleagues[9] found that even a minor five-varus deviation from the mechanical axis significantly affected HDPE wear rates. The gold standard in TKA is mechanical alignment restoration, even if patient dissatisfaction is high.[10] Other studies suggest that restoring a kinematic alignment rather than a neutral mechanical alignment may better mimic the natural knee, improve patient satisfaction, and not increase failure rates.[11,12] Despite popular perception, neutral mechanical alignment does not promote survivability.

2. Kinematic Alignment

The term "knee kinematic alignment" refers to the way in which the knee should be positioned in order to correspond with the anatomical or constitutional alignment of the body. The act of implanting the prosthesis in such a way that it is aligned with the joint line, the axis of the leg, and the tension in the ligaments is referred to as kinematic alignment. Another name for this procedure is complete knee arthroplasty.[13] In accordance with the recommendations made by Weber et al.,[13] kinematically aligned prostheses exhibited a greater degree of range of motion and a better score on the function in knee society scale. Recent meta-analyses have shown conclusive evidence of the benefits associated with having a knee that is appropriately positioned kinematically. As a direct result of using this forward-thinking technique, the rate of prosthesis retention was found to be 97.5% midway through the 10-year follow-up period. The cartilage loss from cutting the femur and tibia will be considered. This part of the procedure aligns the femoral and tibial components in 2-4 more valgus and varus than a mechanically aligned TKA. The hip, knee, ankle, and knee anatomical angles are mostly consistent at this point. Howell defines kinematic alignment as aligning the tibia and femur's articular surfaces parallel to one other and the knee's axis. A united force does this. The leg's normal range of motion is determined by the tibial flexion axis, measured from the two centers of the posterior femoral condyles' circular section.[14,15] The patella's natural arc of flexion and extension on the femur is defined by the patellar flexion axis, which is 10 millimeters anterior to the tibial axis and 12 millimeters proximal.[15] Tibial rotation provides a third axis. This axis also determines the tibia's natural arc of rotation around the femur. In conclusion, the functional consequences of the kinematic alignment strategy are comparable to those of the mechanical alignment method. There is much hope in the results of the midterm elections. Long-term outcomes for mechanical alignment have also been published, demonstrating 80% survival rates after 25 years; however, more research is needed to confirm the positive clinical findings in kinematic alignment over time.[16]

Ligaments are released as part of the gap balancing process before any bone is cut. Ligament release is a reliable treatment for permanent damage. This process is performed before evaluating the rotation of the femoral component because it gets the afflicted limb into a rough state of alignment.[17] There are essentially two options for achieving gap balance. One approach involves establishing symmetry between the two flexion angles. The second method does this by compensating for the predetermined extension gap by increasing knee flexion and decreasing extension.

Bone landmarks that are employed for measured resection devices may vary from patient to patient because to individual differences in femoral anatomy. Malrotation of the femoral component might result from these differences. Using gap balancing helps avoid this issue because it does not rely solely on anatomical clues. The gap balancing method has also been shown to be more effective than measured resection at boosting flexion stability.[18] This is most likely the result of the fact that the measured resection technique generates a femoral condylar lift-off that is noticeably bigger than the gap balancing strategy does.[19] Cutting the proximal tibia requires precise balance. A varus cut may internally rotate the femoral component, whereas a valgus cut may outwardly rotate it. Whether the femoral and/or tibial components were over- or under-resected affects the breadth of the flexion and extension gaps.[20,21]

3. Resection Technique

3.1. Measured resection technique

Depending on femoral landmarks such the AP, TEA, and PCA. The most common marker, principal component analysis (PCA), is 1.5 degrees internally rotated from the TEA.[19] The thigh eminence angle (TEA) is the most reliable landmark for measuring femoral rotation and accurately depicts the patient's natural rotation, but it can be difficult to identify intraoperatively and may require more soft-tissue dissection. Despite being the most dependable marker for femoral rotation, this is the case. Even if the TEA is hard to find.[22,23] In valgus knees, the Whiteside line, which crosses the TEA perpendicularly and reaches the deepest region of the groove, better mimics normal external rotation than the PCA. This discovery was made.

Despite the fact that the Whiteside line passes across the groove's most profound depression, this is still the case.[24] To do a TKA with precision, the surgeon must be aware of all three landmarks. The surgeon has the option of placing the guides in an anterior or posterior location while carrying out a measured resection. By securing the anterior point and preventing any additional bone removal due to changes in femoral component size, anterior reference lowers the likelihood of notching. The design may increase flexion instability by removing too much bone from the posterior femoral condyles. Selecting a design that does not require bone removal during the treatment eliminates this drawback. After setting up the jig, the posterior referencing procedure cuts the femur's posterior. Anterior femoral bone excision may cause notching if the femoral component is exceptionally small. In a medial pivoting device, only the lateral incision depth of the femur rotates. Since lateral pivoting systems have a fixed lateral point, medial bone slices will move independent of rotation. Central pivoting systems' center of rotation may affect posterior femur bone cutting.

Large amounts of criticism have been leveled towards measure resection because of the wide range of patient anatomy. When PCA is done on a knee with valgus deformity, the femoral component may spin inward because to the hypoplastic lateral femoral condyle. Several investigations have found that the PCA exhibits high levels of variability.[22,25] Schnurr et al.[25] found that meal rotation occurred in 49% of instances when PCA was used independently to determine rotation. Additional research showed that both the TEA and the Whiteside line were very variable, casting doubt on their validity as a reference point for anatomy.[26] Adopting this method allows for the avoidance of femoral component malrotation by making full use of all femoral markers for proper component alignment.

3.2. *Gap balancing*

By pulling firm on both collateral ligaments, the femoral component is aligned perpendicular to the tibia that was removed. Depending on the surgeon's preference, this can be done by first striking a balance in the flexion or extension gap. For this method to be effective, the tibial incision must be exact; otherwise, the femoral component will be affected. Gap balancing, which comprises the removal of any osteophytes that may be present, should be carried out prior to femoral excision. Tension is kept up with the aid of technological distractions. It is likely that the landmarks used in the measuring of resection devices are not always correct because of the individual differences in femoral anatomy. If this persists, it might cause the femoral component to malrotate. This issue is circumvented by the fact that gap balancing employs a broader range of indications as opposed to relying just on anatomical ones. Gap balancing has been shown to offer superior flexion stability than the measured resection technique. This is because it causes less lift-off of the femoral condyles.[18,19] The tibia must be sliced accurately to stop the femoral component from spinning. This might occur with any additional varus or valgus. If too much femur is taken away, it may be difficult to keep the flexion gap in check. Because improper balancing can lead to erroneous resections, osteophyte removal and collateral ligament preservation are both crucial. Distraction strategies may be required for balance, and one's stress levels should be monitored quantitatively as well as qualitatively. To prevent excessive resection of the femoral condyles, a tight extensor mechanism causes a pronounced asymmetry in the flexion gap. This is done to avoid excessive resection of the condyles. It is crucial to keep this in mind during the procedure.[20,21]

3.3. *Patient specific instrumentation*

Total knee arthroplasty (TKA) is simplified by patient-specific equipment, which employs high-tech preoperative imaging to create personalized cutting guides. This is essential due to the fact that every patient has a different anatomy. These guides are used to cut the femur and tibia at the correct angles so that conventional, premade implants may be inserted. Imaging systems, which may use CT or MRI technology depending on the client, will capture data from the patient's hips all the way down to their ankles. It is crucial to pay careful thought to patient scheduling since the implants need to be prepared before the procedure. Better implant alignment, fewer outliers, and less active decision-making on the part of the physician are all possible benefits of preoperative templating. These are but a few of the advantages. Reduce the total length of time an operation takes and the number of implant trays that need to be sterilized to perform the surgery. Patients with femoral abnormalities or implants that restrict femoral canal instrumentation might benefit from not having to have blood transfusions as a consequence of reduced blood loss during surgery. Fewer complications, improved alignment, and reduced costs are all claims that have not been adequately investigated. It is not well documented how implant alignment outlier reduction, improved alignment, or higher functional evaluations compare to traditional treatments.[27–31] Although there have been no consistent studies showing a reduction in the amount of time needed for surgery, it is generally considered to have little therapeutic or financial impact.[27,30,31] There is no evidence that cost savings occur,[31] and a research by Barrack et al.38 found a $1,500 premium above standard equipment with only a $322 projected savings. These results are inconsistent with the idea that savings may be made. There is no conclusive evidence that conventional TKA causes less blood loss or transfusion rates, according to Voleti et al.'s meta-analyses.[27] We failed to establish a statistically significant difference between the two different forms of TKA. Before making recommendations about the broad usage of patient-specific equipment in TKA, further substantial and long-term research must be conducted.

4. Computer Navigation and New Techniques

4.1. Computer navigation

If the TKA is not oriented correctly, it may fail before its time. This was a major driving force for the birth of CAS (computer-assisted surgery). There are several research available that may be used to argue for or against the necessity of the many technologies now being used to improve surgical operations. It is crucial to understand the inner workings of each system in CAS in order to realign the mechanical axis. Robotic control is commonly included into active systems to finish a step of the process. Patients do not play an active role in the surgical procedure while using passive systems, which are far more frequent than active ones and allow the physician to maintain complete control. In passive CAS, reflecting spheres that are implanted in the patient's femur and tibia receive infrared light from optical equipment. The specific location of the user in space may then be ascertained by sending this light to a computer for analysis. The main reason of the technology's limitations is frequently attributed to the camera's failure to accurately find the reflecting spheres. Before ferromagnetic instruments were commonplace, magnetic locating methods were frequently employed. These systems didn't have optical trackers' line-of-sight issues, but they did have reliability issues due to distortion. Both free and image-based CAS solutions are available. CT and MRI are image-based technologies; hence it is crucial to employ three-dimensional imaging. In order to compare with the images on the screen, these systems need the surgeon to locate a set number of predetermined landmarks. The possibility of employing a mathematical computer method to map the geometry and establish alignment is being considered. To locate the femoral head and knee's midpoint during a kinematic evaluation of their range of motion, doctors use fixed reflecting spheres. The anatomical midpoint of the ankle can be found using a kinematic analysis or landmarks on the medial and lateral malleoli. A number of scholarly studies have discussed the advantages of CAS. The meta-analysis revealed an improvement in coronal plane accuracy and precision as well as femoral rotation. When an intramedullary guide cannot be utilized because of severe femoral deformities or already instrumented femurs, these devices may be helpful in the treatment of severe femoral issues.[32] By removing the chance of femoral or tibial intramedullary canal transection, the adoption of CAS has the potential to lessen blood loss and the risk of fat embolism.[33] The Knee Society assessments at three, six, and five years did not distinguish between CAS and traditional TKA; as a result, this approach has drawn criticism.[34] Like other medical treatments, surgery has a steep learning curve and takes longer to complete.[35] A transcortical pin put into the femoral pin site increases the risk of femoral pin site fractures, which happen at a rate of 1.3%. Tibial stress fractures are another potential injury.[36] The greater total cost of ownership is compounded by the need for more skilled personnel in the operating room and the higher cost of the technology's necessary components. These supplementary expenses may be reduced by high-throughput operations. There are 250 cases each year, and the savings can vary based on whether or not the anticipated lower revision rate is included in when using CAS.[37,38]

4.2. Inertial navigation system

There is not a lot of information available on how they should be utilized because they were just introduced to the market. The INS calculates the location in space based on the vehicle's velocity and position using data from accelerometers and motion sensors. This aids in decreasing the requirement for CAS sensors. One such INS is KneeAlign, now called OrthoAlign Aliso Viejo. This apparatus fixes the accelerometer in place and causes the limb to carry out a sequence of motions that may be used to pinpoint its exact location. Another device that uses gyroscopes and transmits data to a computer in order to ascertain alignment is the iAssist (Zimmer Biomet) system.[39] Better tibial alignment and fewer tibial slope outliers have been demonstrated with the application of INS compared to conventional extramedullary guides.[40] Compared to CAS, INS for TKA resulted in improved femoral component alignment, required less tourniquet duration, and preserved tibial component alignment. This was determined through studies that looked at both methods side-by-side. Using the accelerometer device prolonged the tibial excision process by a significant amount of time.[41] Because these tools are confined within the operating room,[41] less incisions are required. Despite this, hardly much data on INS is publicly accessible.

4.3. Pressure balancing

Microelectronics provide the means by which the pressure found inside the compartments of the knee may be determined. For instance, utilizing sensors that are implanted in the tibial spacer, one is able to measure the pressure that is present in both the medial and lateral compartments of the knee. These sensors record dynamic femoral contact sites across the whole knee range of motion in addition to kinematic tracking. One item in this group is the Orthosensor VeraSense Knee System. To better manage balance and tracking, more precise surgical releases can be carried out. Dynamic feedback can also be employed to improve the precision with which the knee balances in response to pressure delivered at various sites inside the knee. With the aid of this technology, knee functionality, result assessments, and the requirement for modifications should all be improved.

Up until now, not much has been written about this innovative technique. According to Gustke et al.,[42] patients who were balanced with this device (a difference of 15 pounds between the two compartments) had better patient-reported results and Knee Society Scores. Larger cohorts may be used in future studies to confirm the results of the previous research, which might result in a more precise range for the indicated numbers for equilibrium. The high cost is one of the method's drawbacks. Statistics covering longer time periods are currently unavailable. To effectively learn about the knee's soft tissue homeostasis, more work has to be done, despite the fact that this is a novel and improved gadget.

5. Conclusion

There is a vast variety of surgical options available for TKA nowadays. Although each of these treatments confirm to a distinct worldview, they all show similar levels of patient satisfaction, yet a sizeable minority of patients are still unsatisfied. However, while conventional methods are being enhanced by new technology, the long-term impacts of these endeavors are limited. The anatomical deformations brought on by arthritis add to the difficulty of total knee arthroplasty, which already requires replacing a joint with highly changeable three-dimensional design and mechanics. All of the technologies and strategies discussed in this article are geared on enhancing component placement for optimal long-term performance. To compare the effectiveness of these strategies to more traditional ones in terms of identifying the long-term effect, however, much more study is needed.

6. Source of Funding

None.

7. Conflict of Interest

None.

References

1. Jeffery RS, Morris RW, Denham RA. Coronal alignment after total knee replacement. *J Bone Joint Surg Br*. 1991;73(5):709–14.
2. Insall JN. Total knee replacement. In: Insall JN, editor. Surgery of the Knee. United Kingdom: Churchill Livingstone; 1984. p. 587–696.
3. Green GV, Berend KR, Berend ME, Glisson RR, Vail TP. The effects of varus tibial alignment on proximal tibial surface strain in total knee arthroplasty: The posteromedial hot spot. *J Arthroplasty*. 2002;17(8):1033–9.
4. Bargren JH, Blaha JD, Freeman MA. Alignment in total knee arthroplasty. Correlated biomechanical and clinical observations. *Clin Orthop Relat Res*. 1983;173:178–83.
5. Lotke PA, Ecker ML. Influence of positioning of prosthesis in total knee replacement. *J Bone Joint Surg Am*. 1977;59(1):77–9.
6. Tew M, Waugh W. Tibiofemoral alignment and the results of knee replacement. *J Bone Joint Surg Br*. 1985;67(4):551–6.
7. Ritter MA, Faris PM, Keating EM, Meding JB. Postoperative alignment of total knee replacement. Its effect on survival. *Clin Orthop Relat Res*. 1994;299:153–6.
8. Aglietti P, Buzzi R. Posteriorly stabilised total-condylar knee replacement. Three to eight years' follow-up of 85 knees. *J Bone Joint Surg Br*. 1988;70(2):211–6.
9. Collier MB, Engh CA, McAuley JP, Engh GA. Factors associated with the loss of thickness of polyethylene tibial bearings after knee arthroplasty. *J Bone Joint Surg Am*. 2007;89(6):1306–14.
10. Bourne RB, Chesworth BM, Davis AM, Mahomed NN, Charron KDJ. Patient satisfaction after total knee arthroplasty: Who is satisfied and who is not? *Clin Orthop Relat Res*. 2010;468(1):57–63.
11. Parratte S, Pagnano MW, Trousdale RT, Berry DJ. Effect of postoperative mechanical axis alignment on the fifteen-year survival of modern, cemented total knee replacements. *J Bone Joint Surg Am*. 2010;92(12):2143–9.
12. Bonner TJ, Eardley WG, Patterson P, Gregg PJ. The effect of post-operative mechanical axis alignment on the survival of primary total knee replacements after a follow-up of 15 years. *J Bone Joint Surg Br*. 2011;93(9):1217–22.
13. Weber P, Gollwitzer H. Kinematic alignment in total knee arthroplasty. *Oper Orthop Traumatol*. 2021;33(6):525–37.
14. Stokes IA. Mechanical effects on skeletal growth. *J Musculoskelet Neuronal Interact*. 2002;2(3):277–80.
15. Coughlin KM, Incavo SJ, Churchill DL, Beynnon BD. Tibial axis and patellar position relative to the femoral epicondylar axis during squatting. *J Arthroplasty*. 2003;18(8):1048–55.
16. Evans JT, Walker RW, Evans JP, Blom AW, Sayers A, Whitehouse MR, et al. How long does a knee replacement last? A systematic review and meta-analysis of case series and national registry reports with more than 15 years of follow-up. *Lancet*. 2019;393(10172):655–63.
17. Insall JN, Scott WN. Insall and Scott surgery of the knee. London: Church Livingstone/Elsevier; 2006.
18. Dennis DA, Komistek RD, Kim RH, Sharma A. Gap balancing versus measured resection technique for total knee arthroplasty. *Clin Orthop Relat Res*. 2010;468(1):102–7.
19. Dennis DA, Komistek RD, Walker SA, Cheal EJ, Stiehl JB. Femoral condylar lift-off in vivo in total knee arthroplasty. *J Bone Joint Surg Br*. 2001;83(1):33–9.
20. Matthew A. Measured resection versus gap balancing for total knee arthroplasty. *Clin Orthop Related Res*. 2014;472(7):2016–22.
21. Nagai K, Muratsu H, Matsumoto T, Miya H, Kuroda R, Kurosaka M. Soft tissue balance changes depending on joint distraction force in total knee arthroplasty. *J Arthroplasty*. 2014;29(3):520–4.
22. Poilvache PL, Insall JN, Scuderi GR, Font-Rodriguez DE. Rotational landmarks and sizing of the distal femur in total knee arthroplasty. *Clin Orthop Relat Res*. 1996;331:35–46.
23. Berger RA, Rubash HE, Seel MJ, Thompson WH, Crossett LS. Determining the rotational alignment of the femoral component in total knee arthroplasty using the epicondylar axis. *Clin Orthop Relat Res*. 1993;286:40–7.
24. Arima J, Whiteside LA, Mccarthy DS, White SE. Femoral rotational alignment, based on the anteroposterior axis, in total knee arthroplasty in a valgus knee. A technical note. *J Bone Joint Surg Am*. 1995;77(9):1331–4.
25. Schnurr C, Nessler J, König DP. Is referencing the posterior condyles sufficient to achieve a rectangular flexion gap in total knee arthroplasty? *Int Orthop*. 2009;33(6):1561–5.
26. Yau WP, Chiu KY, Tang WM. How precise is the determination of rotational alignment of the femoral prosthesis in total knee arthroplasty: An in vivo study. *J Arthroplasty*. 2007;22(7):1042–8.
27. Voleti PB, Hamula MJ, Baldwin KD, Lee GC. Current data do not support routine use of patient-specific instrumentation in total knee arthroplasty. *J Arthroplasty*. 2014;29(9):1709–12.

28. Huijbregts HJ, Khan RJ, Fick DP, Hall MJ, Punwar SA, Sorensen E, et al. Component alignment and clinical outcome following total knee arthroplasty: A randomised controlled trial comparing an intramedullary alignment system with patient-specific instrumentation. *Bone Joint J*. 2016;98(8):1043–9.
29. Goyal T, Tripathy SK. Does Patient-Specific Instrumentations Improve Short-Term Functional Outcomes After Total Knee Arthroplasty? A Systematic Review and Meta-Analysis. *J Arthroplasty*. 2016;31(10):2173–80.
30. Abane L, Anract P, Boisgard S, Descamps S, Courpied JP, Hamadouche M. A comparison of patient-specific and conventional instrumentation for total knee arthroplasty: A multicentre randomised controlled trial. *Bone and Joint Journal*. 2015;(1):56–63.
31. Sassoon A, Nam D, Nunley R, Barrack R. Systematic review of patient-specific instrumentation in total knee arthroplasty: New but not improved. *Clin Orthop Relat Res*. 2015;473(1):151–8.
32. Lee CY, Lin SJ, Kuo LT, Peng KT, Huang KC, Huang TW, et al. The benefits of computer-assisted total knee arthroplasty on coronal alignment with marked femoral bowing in Asian patients. *J Orthop Surg Res*. 2014;9:122.
33. Fahmy NR, Chandler HP, Danylchuk K, Matta EB, Sunder N, Siliski JM. Blood-gas and circulatory changes during total knee replacement. Role of the intramedullary alignment rod. *J Bone Joint Surg Am*. 1990;72(1):19–26.
34. Harvie P, Sloan K, Beaver RJ. Computer navigation vs conventional total knee arthroplasty: Five-year functional results of a prospective randomized trial. *J Arthroplasty*. 2012;27(5):667–72.
35. Bauwens K, Matthes G, Wich M, Gebhard F, Hanson B, Ekkernkamp A, et al. Navigated total knee replacement. A meta-analysis. *J Bone Joint Surg Am*. 2007;89(2):261–9.
36. Beldame J, Boisrenoult P, Beaufils P. Pin track induced fractures around computer-assisted TKA. *Orthop Traumatol Surg Res*. 2010;96(3):249–55.
37. Slover JD, Tosteson AN, Bozic KJ, Rubash HE, Malchau H. Impact of hospital volume on the economic value of computer navigation for total knee replacement. *J Bone Joint Surg Am*. 2008;90(7):1492–1500.
38. Novak EJ, Silverstein MD, Bozic KJ. The cost-effectiveness of computer-assisted navigation in total knee arthroplasty. *J Bone Joint Surg Am*. 2007;89(11):2389–97.
39. Scuderi GR, Fallaha M, Masse V, Lavigne P, Amiot LP, Berthiaume MJ. Total knee arthroplasty with a novel navigation system within the surgical field. *Orthop Clin North Am*. 2014;45(2):167–73.
40. Nam D, Cody EA, Nguyen JT, Figgie MP, Mayman DJ. Extramedullary guides versus portable, accelerometer-based navigation for tibial alignment in total knee arthroplasty: A randomized, controlled trial: Winner of the 2013 HAP PAUL award. *J Arthroplasty*. 2014;29(2):288–94.
41. Nam D, Weeks KD, Reinhardt KR, Nawabi DH, Cross MB, Mayman DJ. Accelerometer-based, portable navigation vs imageless, large-console computer-assisted navigation in total knee arthroplasty: A comparison of radiographic results. *J Arthroplasty*. 2013;28(2):255–61.
42. Gustke KA, Golladay GJ, Roche MW, Elson LC, Anderson CR. A new method for defining balance: promising short-term clinical outcomes of sensor-guided TKA. *J Arthroplasty*. 2014;29(5):955–60.

Author biography

Nagesh Sherikar, Assistant Professor https://orcid.org/0000-0002-1550-4012

Nitin Rawal, Assistant Professor https://orcid.org/0000-0003-3768-0858

Mahesh Gowda, Senior Resident https://orcid.org/0009-0001-5728-1347

Rakshith Chakravarthy H Y, Assistant Professor https://orcid.org/0000-0003-3012-3653

Cite this article: Sherikar N, Rawal N, Gowda M, Chakravarthy H Y R. Total knee arthroplasty, different alignment and balance methods- A review. *Indian J Orthop Surg* 2023;9(4):211-216.