International Journal of Surgery Case Reports 93 (2022) 106945

Contents lists available at ScienceDirect

International Journal of Surgery Case Reports

journal homepage: www.elsevier.com/locate/ijscr

Case report

Tibial reference point in total knee arthroplasty in patient with proximal tibia vara: A case report

John Christian Parsaoran Butarbutar *, Lasa Dhakka Siahaan, Prettysia Suvarly, Muhammad Alwy Sugiarto

Department of Orthopedics and Traumatology, Faculty of Medicine Universitas Pelita Harapan, Siloam Hospitals Lippo Village, Jl. Siloam No.6, Bencongan, Kelapa Dua, Tangerang, Banten, Indonesia

ARTICLE INFO

Keywords:
Tibial reference point
Total knee arthroplasty
Tibia vara
Case report
Varus knee malignment

ABSTRACT

Introduction: Center of the intercondylar eminence at the proximal tibia had been widely used as a reference point for tibial bone cut in the Total Knee Arthroplasty (TKA) procedure. However, in the presence of preexisting tibia vara, the center of intercondylar eminence as tibial bone cut reference point often leads to varus malalignment after TKA procedure.

Case report: 75 years old male patient complained of worsening pain on the left knee. The patient has had a history of knee osteoarthritis for the past seven years. The radiograph on the right knee revealed osteoarthritis grade 3 and left knee osteoarthritis grade 4, both with tibia vara. We planned to perform total knee arthroplasty surgery on his left knee with a preoperative planning tibial reference point of 10 mm lateral to the center. Six months after the knee replacement, there was minimal pain on activity, and full ROM was achieved on his left knee. On the radiographic X-ray evaluation, the alignment between the tibial implant surface and mechanical axis is 0.43 degrees valgus.

Clinical discussion: In a varus knee malignment, the mechanical axis passes through one-third of the medial side of the knee, which makes the medial side of the implant wear off faster, resulting in the collapse of the medial tibia, thus decreasing implant survival and increasing the need for revision for TKA.

Conclusion: In patients with preexisting tibia vara, tibial bone cut reference point planning before TKA procedure is important to provide longevity of implant survival and better quality of life.

1. Introduction

Total Knee Arthroplasty (TKA) is a common surgical procedure indicated for knee disorders, primarily osteoarthritis. TKA improves patients' quality of life by reducing pain and improving the function of knee disorders [1]. In TKA, normal coronal alignment and correct placement of the femoral and tibial implants perpendicular to the mechanical axis is important for patient quality of life and long-term implant survival. The correct alignment by bone cuts, prosthesis positioning, and soft tissue balancing will restore the neutral mechanical axis of the femur and tibia in the coronal plane [2–8]. McGrory, in his study, describes that restoring normal mechanical axis correlates with improved long-term implant survival [4]. Fang, in his study, also describes the coronal alignment as a predictor for TKA revision [9].

According to Saibaba's research, in patients with varus arthritic knees, an undetected, yet considerable, extra-articular varus angulation may exist at the proximal metaphyseo-diaphyseal junction of the tibia [7]. The center of the intercondylar eminence had been widely used as a reference point for tibial bone cut at the proximal tibia in TKA [2]. But in the presence of preexisting tibia vara, the center of intercondylar eminence as a tibial bone cut reference often leads to varus malalignment after TKA procedure [2,7,10]. The implant in TKA procedure will fail faster in varus knees primarily from medial tibial collapse because of implant wear and in valgus knees from ligament instability [8,9]. In a study by Fang, varus knees after TKA increases the risk of failure 6,9 times compared with properly aligned knees [9]. Tibia vara deformity identified at the proximal part of the tibia, studies reported that the closer to the joint the deformity, the more it will affect articulation and alignment to the nearest joint, but the closer to the joint the deformity, the more it will be possible to correct the axis or the alignment through intra-articular bone cuts [5,6].

The purpose of this study was to describe the importance of

* Corresponding author.
E-mail address: john.butarbutar@lecturer.uph.edu (J.C.P. Butarbutar).

https://doi.org/10.1016/j.ijscr.2022.106945
Received 26 January 2022; Received in revised form 12 March 2022; Accepted 13 March 2022
Available online 16 March 2022

identifying preexisting tibia vara and the importance of tibial cuts planning prior to TKA procedure to decrease the risk of implant failure and improve implant survival after TKA. This article follows the SCARE checklist and recommendations, and our patient gave his approval for the data acquired in this report to be published [11].

2. Case report

A patient, 75 years old male, came to our outpatient department with the chief complaint of worsening pain on the left knee. The pain worsens on walking and standing for a long period of time and relieves at rest. The patient had a history of knee osteoarthritis for the past seven years. The patient was overweight with a Body mass index of 29. He was routinely consuming pain killer when he felt the pain unbearable. There was no history of diabetes mellitus and hypertension, and there was no history of trauma on the knee.

On the physical examination, we found a stable bilateral genu varus condition. There was genu varus with effusion, medial line tenderness on the left knee, and range movement was limited with 20–135° on both knees. There is no sign of inflammation on the knee. The Long limb X-ray Radiograph revealed osteoarthritis Kellgren-Lawrence grade 4 and 3, on right and left knee respectively, with tibia vara (Fig. 1).

After diagnosis was established, we planned to perform total knee arthroplasty surgery on his left knee. We considered performing one side first because of the patient's age, the prominent pain on the left knee, and the degree of the tibia vara on the left knee is greater than the right knee. The surgery was conducted in Siloam Hospital Lippo Village, Indonesia, by experienced orthopedic surgeon (JBB). The lateral reference point of the proximal tibia was calculated using the preoperative long limb X-ray using computer on the preoperative planning (Fig. 2). First, we draw a line along the tibial articular surface (A, Fig. 2). Second, we draw a line along the anatomical axis of the tibia by bisecting the medullary canal (B, Fig. 2). Then, we draw a line perpendicular to the tibial articular surface at the center of the tibial intercondylar eminence (C, Fig. 2). The angle formed between lines B and C is the degree of the tibia vara (α, Fig. 2). The tibial reference point that would be used intraoperatively as a guide is determined by the distance between points of intersection of A-B and A-C (β, Fig. 2).

The distance between the center of the intercondylar eminence and the tibial reference point (β) in this case is 10 mm lateral to the center of intercondylar eminence, and the degree of the tibia vara (α) was 5,96° based on the preoperative planning (Fig. 2). Intraoperatively, the proximal extramedullary jig is placed at the planned point (D) using the measurement as a guide, and the distal part is placed at the center of the talus. The rest of the TKA is done in the usual way. The patient was discharged from the hospital five days later after the patient was able to walk to the bathroom independently with walkers. Six months after the TKA, there was minimal pain on activity, and full ROM was achieved on his left knee. On the radiographic X-ray evaluation, the position of the implant is good, and the alignment between the tibial implant surface and mechanical axis is 0.43 degrees valgus (Fig. 3). After two years the patient do not complaint any pain, the knee is stable and the patient feel satisfied with the procedure.

3. Discussion

In TKA procedure, the function and durability of the implant are determined by multiple factors, such as surgeon, patient, and implant factor. Among all that factors, proper implant positioning to achieve coronal alignment of the leg is one of the most important points [9]. To achieve coronal alignment during the TKA procedure, we need to position the implant properly, conserve bone as much as possible and preserve the collateral ligaments and the extensors part of the knee [5]. Coronal alignment of the leg after TKA procedure will restore neutral mechanical axis of the leg, thus improving long term survival of the implant and quality of life of the patient [2–9].

Fig. 1. Long limb X-ray radiograph.

The center of the intercondylar eminence at the proximal tibia had been widely used as a reference point for the tibial bone cut in the TKA procedure [2]. But in the presence of preexisting tibia vara, the center of intercondylar eminence as the tibial bone cut reference often leads to varus malalignment after TKA procedure [2,7,8,10]. In the varus malalignment, the lower leg mechanical axis of the leg will not be in line with the anatomical axis of the tibia and the mechanical axis will pass through one-third of the medial side of the knee instead of the central third of the knee [2,4,5]. When the mechanical axis passed through one third the medial side of the knee, the medial side of the implant would be worn off faster, resulting in the collapse of the medial tibia, thus decreasing implant survival and increasing the need for revision of TKA [7–10]. Han, in his study, described that coronal alignment of the tibia

Fig. 2. Measurement of tibial reference point. (A): Line formed based on tibial articular surface. (B): Line formed based on anatomical axis of tibia. (C): Line formed perpendicular to line A at the center of the tibial intercondylar eminence. (β): Distance between point of intersection line A-B and A-C. (α): The angle between line B and line C.

could be achieved with a tibial bone cut that has to be made perpendicular to the tibia mechanical axis or within 3° in either varus or valgus alignment [8]. Moreover, in recent studies, implant survival improved when the mechanical axis of the lower leg after the TKA procedure passed through the central third of the knee [4].

The anthropometric of the bones in Asian populations differ markedly from western populations. A study reported that the lower leg alignment in young Chinese populations was more varus than Caucasians. Moreover, in a group of end-stage osteoarthritis (OA) of the knee among Asians, bowing of the leg is not uncommon [3]. In varus knees, there is 6,9 times increased risk of failure TKA compared with properly aligned knees. As described in a study by Fang, thirteen of the eighteen of the varus knee failures were due to medial tibial collapse [9]. Fang also described the best implant survival rate found in overall coronal alignment between 2.4° and 7.2° of valgus following the TKA procedure [9]. To achieve normal coronal alignment in preexisting tibia vara during TKA, the tibial bone cut reference should be calculated according to the degree of the tibia vara deformity.

Kim Sang-Min, in his study, used lateral intercondylar eminence as a fixed reference for the tibial bone cut in varus knees and then investigated the accuracy of coronal alignment after TKA procedure in anatomical replica sawbones [2]. The result of his study is that lateral intercondylar eminence can be used as a tibial bone cut reference to achieve proper coronal alignment in varus knees [2]. Thippana and Saibaba, in their study, also used lateral tibial bone cut reference in preexisting tibia vara [7,10]. However, Thippana et al. calculated the reference point based on the degree of tibia vara deformity rather than the fixed reference point at the lateral intercondylar eminence, and it can extend further lateral than the lateral intercondylar eminence [10]. The result of her study results show that TKA using the calculated lateral tibial bone cut reference point provides more satisfactory coronal alignment than using the center intercondylar imminence as a reference point in preexisting tibia vara deformity [10]. This study proved the

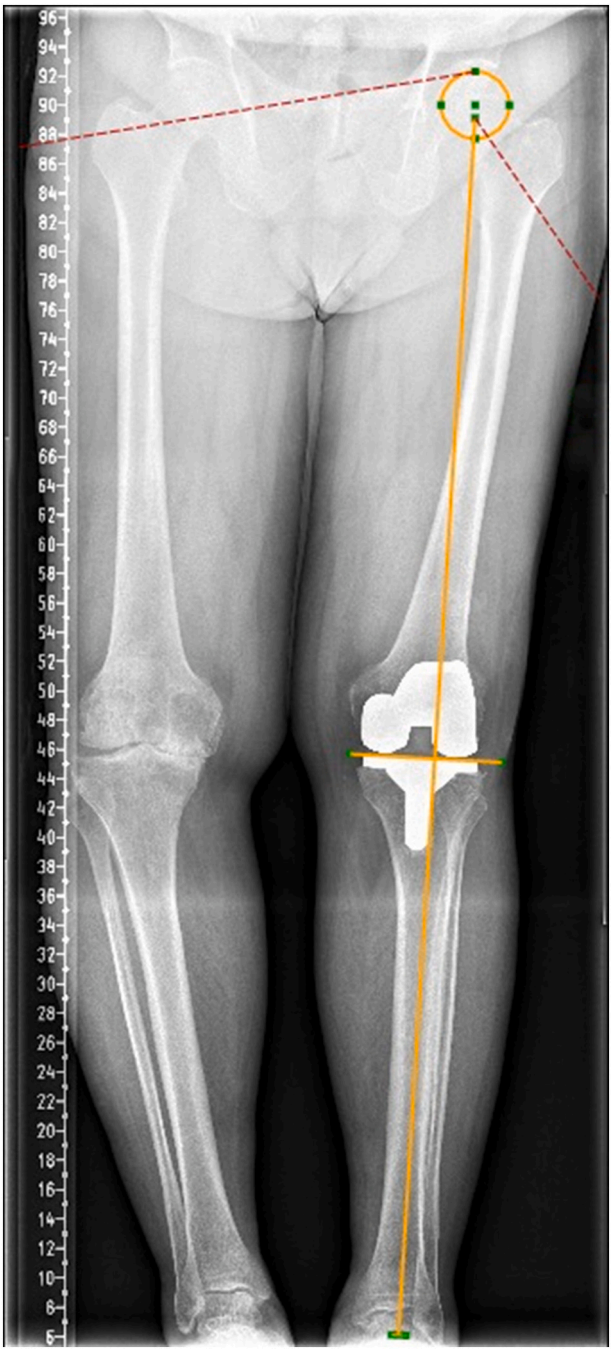

Fig. 3. Postoperative long limb X-ray radiograph showed the alignment between the tibial implant surface and mechanical axis is 0.43 degrees valgus.

importance of tibial bone cut planning prior to TKA procedure with preexisting tibia vara deformity to provide implant survival.

Weight-bearing (standing) long leg radiograph has been the gold standard for assessing leg alignment [5,9]. Standing long leg radiograph could be used for preoperative planning to identify bowing of the leg caused by femoral or tibial deformity, in this case, tibia vara [3,4]. In the preoperative planning, the degree of the tibia vara and the lateralization of tibial bone cut reference were measured to be used for the TKA procedure. Yau, in his study, recommends using an anteroposterior (AP) standing long leg radiograph instead of short films for preoperative TKA planning, especially in populations with a high incidence of varus deformity, for example, Asian populations [3]. If standing long-leg radiographs are not available, commonly due to unavailable long films,

conventional x-rays may be taken separately with the same magnification in full weight bearing (standing) manner and put together as a puzzle afterwards to assess the leg alignment [5,7].

The TKA procedure used extramedullary (EM) and intramedullary (IM) system alignment to navigate tibial bone cutting. Both systems are commonly used, and choosing between EM or IM alignment systems is based on the surgeon's consideration and examination. However, in recent studies, an EM alignment system is preferred instead of an IM alignment system if bowing of the leg is found during the planning of TKA [3,4]. During TKA with IM alignment system, the IM rod has to be inserted parallel to the mechanical axis of the tibia to achieve optimal tibial bone cut. For this reason, to use the IM alignment system, the tibia's anatomical axis and mechanical axis must be parallel to each other, which is not found in tibia vara [7]. IM alignment system used in patients with bowing of the leg may result in a tibial bone cut perpendicular to the proximal tibia's anatomical axis, but not perpendicular to the mechanical axis of the tibia. Therefore, the EM alignment system is preferred in patients with bowing of the leg to enhance the accuracy of the tibial bone cutting [4,5].

4. Conclusion

In patients with preexisting tibia vara, tibial bone cut reference point planning prior to TKA procedure is important to provide longevity of implant survival and better quality of life. In our case, the point is located lateral to the traditional reference point.

Source of funding

This study did not receive any specific grant from funding agencies, commercial, or not-for-profit sectors.

Ethical approval

This study has been reviewed and approved by the authors' Institutional Review Board.

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Author contribution

John Christian Parsaoran Butarbutar: conceptualization, writing original draft preparation, final approval, writing the paper and editing, supervision.

Lasa Dhakka Siahaan: data collecting, data interpretation, writing original draft preparation, writing the paper and editing, final approval.

Prettysia Suvarly: data collecting, data interpretation, writing original draft preparation, writing the paper and editing, final approval.

Muhammad Alwy Sugiarto: data collecting, data interpretation, writing original draft preparation, writing the paper and editing, final approval.

Registration of research studies

This Case report is not “First in Man” Study.

Guarantor

John Christian Parsaoran Butarbutar.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Declaration of competing interest

We declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] J.A. Singh, Epidemiology of knee and hip arthroplasty: a systematic review, Open Orthop. J. 5 (2011) 80–85.
[2] Kim Sang Min, Kim Keun Woo, Cha Sung Mu, Han Kye Young, Proximal tibialresection in varus-deformed tibiae during total knee arthroplasty: an in vitro study using sawbone model, Int. Orthop. 39 (3) (2015) 429–434, https://doi.org/10.1007/s00264-014-2485-9.
[3] W.P. Yau, K.Y. Chiu, W.M. Tang, T.P. Ng, Coronal bowing of the femur and tibia in chinese: its incidence and effects on total knee arthroplasty planning, J. Orthop. Surg. 15 (1) (2007) 32–36.
[4] T. Trousdale Robert, W. Pagnano Mark, Nigbur Michael, E. McGrory John, Preoperative hip to ankle radiographs in totalknee arthroplasty, Clin. Orthropaedics Relat. Res. 404 (2002) 196–202.
[5] P. Vedoya Santiago, Garabano German, Hernan J. Del Sel, Total knee arthroplasty associate with extra-articular deformity, MOJ Orthop. Rheumatol. 8 (6) (2017) 00335.
[6] Rajgopal Ashok, Vasdev Attique, Dahiya Vivek, C. Tyagi Vipin, Gupta Himanshu, 47, Indian J. Orthop. (1) (2013) 35–40.
[7] Saibaba Balaji, S Dhillon Mandeep, K Chouhan Devendra, K Kanojia Rajendra, Prakash Mahesh, Bachhal Vikas. Significant Incidence of Extra-articular Tibia Vara Affects Radiological Outcome of Total Knee Arthroplasty.
[8] Han Kye Young, Chae Young Woo, The position of proximal reference point of tibia plateau for correct tibial osteotomy in total knee replacement: prospective randomized and 6 years follow-up study, Knee Surg. Relat. Res. 23 (4) (2011) 197–202.
[9] M. Fang David, A. Ritter Nerrill, Kenneth E. Davis, Coronal alignment in total knee arthroplasty, J. Arthroplast. 24 (6) (2009) 39–43.
[10] K. Thippana Rajshekhar, Malhar N. Kumar, Lateralization of tibial pleateau reference point inplroves accuracy of tibial resection in total knee arthroplasty in patients with proximal tibia vara, Clin. Orthop. Surg. 9 (4) (2017) 458–464.
[11] R.A. Agha, T. Franchi, C. Sohrabi, G. Mathew, for the SCARE Group, The SCARE 2020 guideline: updating consensus Surgical CAse REport (SCARE) guidelines, Int. J. Surg. 84 (2020) 226–230.