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Original Research Article

Comparison of Aescula and Tomofix Plate for Biplanar Open Wedge High Tibial Osteotomy in the Medial Compartment of Knee Arthritis

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Abstract:

Background: One of the treatments for unicompartmental osteoarthritis of the knee joint is high tibial osteotomy (HTO), which can be carried out using an open wedge, closed wedge, or dome osteotomy. Due to its exact angle correction, restoration of knee joint stability, and fibula preservation, open wedge HTO is currently widely used. This study compared the outcomes of biplanar open wedge high tibial osteotomies performed with Aescula and TomoFix plates in medial osteoarthritis of the knee joints with varus deformity.

Methods: Biplanar open wedge high tibial osteotomies in 50 consecutive patients were retrospectively assessed. 25 instances were treated in Group A using the Aescula plate, and 25 cases were treated in Group T using the TomoFix plate. In groups A and T, full weight-bearing was permitted at 6 weeks and 2 weeks, respectively, following surgery. At the last follow-up, clinical assessments were carried out utilizing postoperative knee scores and functional scores. The postoperative mechanical femur-tibia angle, the change in posterior tibial slope angle, and implant-related problems were also examined on radiographs. In group A, the mean follow-up length was 30 months, while in group T, it was 26 months.

Results: At the final follow-up, both groups' knee and functional ratings had improved ($p < 0.05$), but there had been no differences between the two groups ($p > 0.05$). 52% of group A and 84% of group T both received an acceptable correction angle ($p = 0.015$). The posterior tibial slope was better maintained in group T, as evidenced by the bigger change in posterior tibial slope angle in group A than in group T ($p < 0.001$). Three screw loosening cases and four delayed union cases were found in group A. Seven cases (6 in group A and 1 in group T) also had persistent varus abnormalities.

Conclusions: Compared to the Aescula spacer plate, firm fixation utilizing a TomoFix plate for open wedge high tibial osteotomy results in improved radiologic outcomes and a lower complication rate.

Keywords: Knee, Osteoarthritis, Osteotomy, Comparative study, Aescula plate, TomoFix plate.

Introduction

One of the treatments for unicompartmental osteoarthritis of the knee joint is high tibial osteotomy (HTO), which can be carried out using an open wedge, closed wedge, or dome osteotomy. [1,2]

Due to its exact angle correction, restoration of knee joint stability, and fibula preservation, open wedge HTO is currently widely used. A spacer plate like the Puddu plate (Arthrex, Naples, FL, USA) or the Aescula plate (B. Braun Korea, Seoul, Korea) or a plate fixator like the TomoFix plate (Synthes, Solothan, Swiss) are the fixation tools utilized for medial open wedge HTO (Fig. 1). [3] The former has the benefits of a small, low profile and a small soft tissue incision; however, it has the disadvantages of a longer period of immobilization (six weeks after surgery), [4,5] frequent complications from the difficulty of maintaining the correction angle during the bone healing period, non-union, fixator failure, [6-8] and increased posterior tibial slope. [9] The latter, on the other hand, has the disadvantage of having more extensive skin and soft tissue incisions but the advantages of firm fixation, early range of motion, early weight-bearing (two weeks following surgery), [10] and maintenance of a normal preoperative posterior tibial slope. [9-12]Despite the aforementioned benefits and drawbacks, it was predicted that the clinical and radiological results and complications following medial open wedge HTO for the spacer plate group and the plate fixator group would be comparable for this study.

The goal of the current study is to evaluate the clinical and radiologic results and consequences following biplanar medial open wedge HTO in medial osteoarthritis of the knee joint with varus

deformity utilizing the Aescula plate or the TomoFix plate.

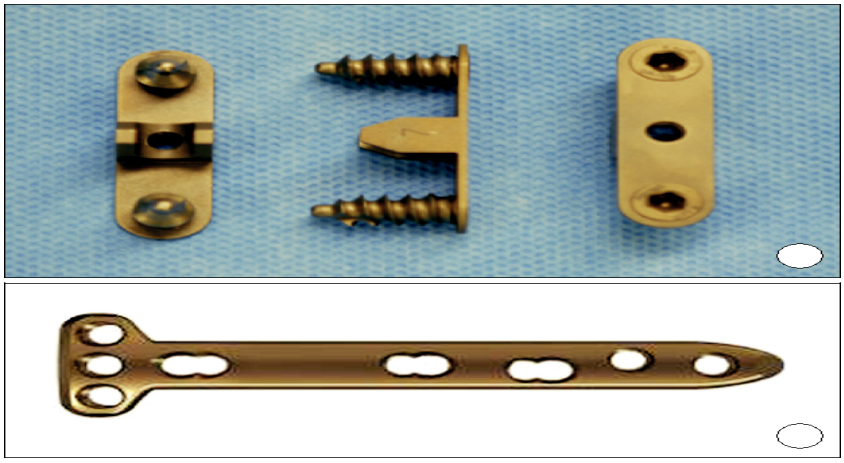

Figure 1: (A) Aescula plate. (B) TomoFix plate

Material and Methods

This investigation was carried out at the orthopaedic department of Patna Medical College and Hospital, Patna, Bihar. A sequential series of 48 patients treated from April 2021 to September 2021 included 50 cases of biplanar open wedge HTOs. The 25 cases (24 patients) in group A were treated with the Aescula plate, and the 25 cases (24 patients) in group T were treated with the TomoFix plate.

No rules existed to specify which plate would be used. Included conditions included varus limb alignment, symptomatic medial osteoarthritis of the knee, and an intact lateral joint compartment. Exclusion criteria were active infection on the knee joint, severe osteoarthritis of the patellofemoral joint, and flexion contracture of > 15° or flexion < 90°. Demographic features such as age, gender, preoperative varus deformity, and body mass index did not differ significantly between the two groups.

Anteroposterior full-leg radiographs were collected while the patients were standing on both legs and the knee joint was fully extended to assess the mechanical femoral-tibial angles (mF-TAs) prior to surgery. At the Fugisawa position, which is 62.5% away from the medial tibial articular edge and where the mechanical axis of the lower limb passed through, the target corrective angle was measured. A diagnostic arthroscopy, cartilage debridement, and/or partial meniscectomy were performed in all patients.

The medial side of the tibial tuberosity (about 5 cm) was the location of a longitudinal skin incision. Underneath the osteotomy site, the pes anserinus and the superficial medial collateral ligament (MCL) were totally freed. Biplanar osteotomy, which involves oblique coronal osteotomy at an angle of 130 degrees to the horizontal oblique osteotomy and targets the tip of the fibular head, was carried out. [6] A bone chisel and a laminar spreader were used to spread the osteotomy site after biplanar osteotomy was finished, until the cable line from the hip center to the ankle center crossed through the Fugisawa point. [13] Afterward, the osteotomy site was fixed to each plate while being guided by a fluoroscope. The correction amount was allowed if the cable lines the limb's mechanical axispassed through between 62% and 66% of the tibial width from the medial tibial articular edge. [14] Allograft chip bone combined with autologous bone marrow was used to bridge the osteotomy gap. After that, the pes anserinus was reattached to the periosteum and the removed superficial MCL was used to cover the bone graft site. Both groups started active range of motion two weeks following surgery, whereas group A and group T commenced full weight-bearing at six weeks and two weeks, respectively.

Final assessments were conducted using mFTAs, changes in posterior tibial slope angle (pTSA), and knee and function scores from the American Knee Society. The range of mFAT that was considered acceptable was valgus 3° to 6°, and under- and overcorrections were assessed. [15-17] The distance between the medial tibial plateau and the posterior tibial cortex was used to measure the posterior tibial slope. The implants' potential side effects were also assessed.

The statistical analysis was done using chi-square test to make comparison between the proportion of two groups in IBM SPSS ver. [19] and statistical significance was accepted for p-values < 0.05. To compare between the mean of two groups, we used Mann-Whitney U-test which is nonparametric test, as cases were small and could not satisfy normal.

Results

Knee and function scores significantly improved after osteotomy (p = 0.001), but no significant

difference was found between the A and T groups (p> 0.05) (Table 1). At the final follow-up, mean mFTAs during weight-bearing showed more valgus correction in the group T (3.4° vs. 1.7°).

An acceptable correction angle was obtained in 52% of group A and in 84% of group T (p = 0.015). Undercor-rection at the final follow-up was observed in 44% of group A and in 8% of group T, and overcorrection was observed in 4% of group A and in 8% of group T (Table 2).

Residual varus deformity (mFTA < 0°) after osteotomy was present in 7 cases: 6 cases (3.5° varus) in group A and 1 case (1.7° varus) in group T. Preoperative varus deformity was 11.7° 2.3° in group A and 10° in group T. Four cases in group A and one case in group T with postoperative varus defor-mity showed severe deformation (mFTA > 10°). pTSA was increased at the final follow-up in both groups: 72% in group A and 52% in group T (p = 0.244). The increase in pTSA was greater in group A than in group T (p = 0.016).

Furthermore, the change of pTSA was larger in group A than in group T (p< 0.001), which indi-cates better posterior tibial slope maintenance in group T. A change in slope ≥ 5° was observed in 11 cases in group A and in a case in group T (p = 0.001) (Table 2).

In group A, there were three cases of screw loosening (Fig. 2) and 4 cases of delayed union at > 6 months after surgery (Fig. 3). The other 46 cases achieved bone union at 3 months after osteotomy. Finally, skin irritation attributed to the larger TomoFix plate, which occurred in one case in group T.

Table 1: American Knee Society Knee and Function Scores

Variables	Group A	Group T	p-value
Knee score			
□ Preoperation	52.0±12.2	49.5±710.2	0.855
□ Follow-up	89.7±7.0	91.7±6.9	0.612
Function score			
□ Preoperation	59.3±13.1	55.1±12.1	0.756
□ Follow-up	87.3±2.2	92.1±8.8	0.075

Variables are presented as mean ± standard deviation

Table 2: Mechanical Axis and Tibial Slope Changes after Surgery

Variable	Group A		Group T		p-value (%)	p-value (0)
	No. (%)	Angle (0)	No. (%)	Angle (0)		
Femur-tibia mechanical axis						
□ Overall correction	25(100)	1.7±3.3(-4.7 to	25(100)	3.4±1.7(-0.9 to 7.9)	0.015	0.174
angle (0)	13(52)	11)	21(84)	3.3±0.4		0.228
□ 30-60 valgus correction	1(4)	3.6±0.8	2(8)	7.9		
□ Overcorrection	11(44)	11	2(8)	-0.4		
□ Under correction		1.4±2.0				
Tibial slope change						0.213
□ Overall change	25(100)	1.8±4.8(-11 to 9)	25(100)	0.4±2.6(-3.4 to 8.1)	0.244	0.016
□ Increased slop	18(72)	4.5±2.3	13(52)	2.5±2.0		
□ Decreased slop	7(28)	5.1±5.5	12(48)	-1.9±1		
Slope change*	25(100)	4.5±2.6 (0 to 11)	25(100)	2.2±1.6(0 to 8.1)		<0.001
□ Slop change <50	14(56)		24(96)		0.001	
□ Slop change ≥50	11(44)		1(4)		0.001	

*Absolute value of slope change.

Figure 2: Screw loosening was observed in the Aescula plate group at 3months after surgery

A B C D E F

Figure 3: Delayed union was observed in the Aescula plate group: (A) immediately after surgery, (B) at 3 months postoperatively, (C) at 5 months postoperatively, (D) at 9 months postoperatively, (E) at 14 months postoperatively, and (F) at 20 months postoperatively.

Discussion

The present study shows that better and acceptable correction of the mFTA was achieved in the TomoFix plate group. Furthermore, pTSAs were better maintained, and the complication rate was lower in the TomoFix group.

Pape et al. [3] reported of a 30 -subject clinical trial, where the subjects underwent open wedge-HTO by using a spacer plate or plate fixator, and the fixation stability was assessed over a 2-year period by radiostereometric analysis (RSA). Postoperative RSA data showed significantly higher lateral translation of the distal tibia and significantly more subsidence, varus, and internal rotation of the tibial head in the spacer plate group than in the plate fixator group.

Furthermore, weight-bearing following spacer plate fixation induced significant micro-motion at 6 weeks after surgery. The authors concluded that early weight-bearing is appropriate for plate fixator fixation, and that spacer plate fixation should be prolonged for up to 8–10 weeks to avoid pseudoarthrosis and/or the recurrence of varus angulation. Spahn [8] reported that a Puddu spacer plate group showed higher incidence of hematoma, infection, and implant failure rates, and they needed longer rehabilitation period than the plate fixator group. Staubli and Jacob [18] and Zaki and Rae [19] reported of good bone healing without bone graft or substitute in a TomoFix plate group. Asada et al. [9] reported of an increase in posterior tibial slope after open wedge-HTO and suggested that this increase was possibly caused by coronal correction loss when a spacer plate fixator was used. They found that it was necessary to fix anterior and posterior gaps separately. The correction angle in coronal plane had a trade-off relationship with the changes in posterior tibial slope. However, TomoFix plate was possible for rigid fixation, early range of motion, weight-bearing, and maintenance of posterior tibial slope.

In the present study, full weight-bearing was allowed at 6 weeks after surgery in group A, but at 2 weeks in group T. In group A, screw loosening occurred in 3 cases and de-layed union occurred in

4 cases. In group T, skin irritation related to the plate occurred in 1 case, and no other com-plication related to bone union or the plate was observed; and bone union was obtained at 3 months after surgery. Furthermore, the under-correction rate of mFTA was greater in group A. The maximum space thickness of the Aescula plate was 13 mm, and it was difficult to achieve an acceptable angle in the cases with > 10° of varus deformity. When a mFTA of > 3° valgus was required, a posterior gap opening of > 13 mm was necessary, but no suitable larger Aescula plate was available. The TomoFix plate enabled the corrections of deformities exceeding 20°. [20]

In a previous study on pTSA, changes in pTSA of < 5° were not clinically significant in the femoral-tibial position. [21,22] In the present study, a change in slope of ≥ 5° was observed in 11 cases in group A and in 1 case in group T. pTSA was higher in group A at the final follow-up, which was presumed to be due to the Aescula plate or some technical issue. To adequately maintain the posterior tibial slope, the opening ratio of the anterior to posterior gap should be 1 to 2. In order to achieve this ratio, the knee joint should be at an extended position after osteotomy.

The placement of an Aescula spacer plate in posterior aspect adequately prevented closure of the intended anterior gap, and posterior tibial slope was increased. Furthermore, we believe that under correction in the coronal plane in the cases of severe varus deformity increased posterior tibial slope, as described by Asada et al. However, poste-rior tibial slope control in the sagittal plane was easier during TomoFix plate fixation. A single screw was fixed in the distal plate after fixing proximal screws, and the knee joint was then placed in the extended position to adjust posterior tibial slope under fluoroscopy guidance; and fixation was completed by inserting a screw in the remaining distal hole.

Screw loosening occurred in 3 cases in group A. We attribute this to postmenopausal osteoporosis, the low profile plate, and the non-locking nature of the Aescula plate, whereas the TomoFix plate is a locking plate. Thus, we suggest that the bone mineral density of the proximal tibial metaphysis can be determined preoperatively. Nevertheless, we would expect to see favorable results after open wedge HTO, when a plate fixator such as the TomoFix plate is used in the cases of severe varus deformity or with a weak tibial metaphysis.

Several limitations of the present study require consideration. In particular, this study is limited by its retrospective design, small cohort, and short follow-up period. Thus, we suggest that further larger-scale studies should be conducted with a longer follow -up period to explore further possible relations between these plate types and clinical results. In addition, we did not evaluate tibial bone density preoperatively, which could have reduced complications like screw loosening. This study shows that firm fixation using a TomoFix plate for open wedge HTO produces better radiologic results and a low complication rate, than the shorter Aescula spacer plate.

Conclusions

In contrast to the Aescula spacer plate, firm fixation utilizing a TomoFix plate for open wedge high tibial osteotomy results in improved radiologic outcomes and a lower complication rate.

References

1. Asada S, Akagi M, Mori S, Matsushita T, Hashimoto K, Hamanishi C. Increase in posterior tibial slope would result in correction loss in frontal plane after medial open-wedge high tibial osteotomy. Knee Surg Sports Traumatol Arthrosc. 2012; 20(3):571-8.
2. Brinkman JM, Lobenhoffer P, Agneskirchner JD, Staubli AE, Wymenga AB, van Heerwaarden RJ. Osteotomies around the knee: patient selection, stability of fixation and bone healing in high tibial osteotomies. J Bone Joint Surg Br. 2008; 90(12):1548-57.
3. Brinkman JM, Luites JW, Wymenga AB, van Heerwaarden RJ. Early full weight bearing is safe in open-wedge high tibial osteotomy. Acta Orthop. 2010; 81(2):193-8.
4. Fujisawa Y, Masuhara K, Shiomi S. The effect of high tibial osteotomy on osteoarthritis of the knee: an arthroscopic study of 54 knee joints. Orthop Clin North Am. 1979; 10(3): 585-608.
5. Hernigou P, Medevielle D, Debeyre J, Goutallier D. Proxi-mal tibial osteotomy for osteoarthritis with varus deformity: a ten to thirteen-year follow-up study. J Bone Joint Surg Am. 1987; 69(3):332-54.
6. Hofmann AA, Kane KR. Total knee arthroplasty after high tibial osteotomy. Orthopedics. 1994; 17(9):887-90.
7. Keene JS, Dyreby JR Jr. High tibial osteotomy in the treat-ment of osteoarthritis of the knee: the role of preoperative arthroscopy. J Bone Joint Surg Am. 1983; 65(1):36-42.
8. Lobenhoffer P, Agneskirchner JD. Improvements in surgical technique of valgus high tibial osteotomy. Knee Surg Sports Traumatol Arthrosc. 2003; 11(3):132-8.
9. Niemeyer P, Schmal H, Hauschild O, von Heyden J, Sud-kamp NP, Kostler W. Open-wedge osteotomy using an internal plate fixator in patients with medial-compartment gonarthritis and varus malalignment: 3-year results with regard to preoperative arthroscopic and radiographic find-ings. Arthroscopy. 2010; 26(12):1607-16.

10. Noyes FR, Barber SD, Simon R. High tibial osteotomy and ligament reconstruction in varus angulated, anterior cruci-ate ligament-deficient knees: a two- to seven-year follow-up study. Am J Sports Med. 1993; 21(1):2-12.
11. Pape D, Kohn D, van Giffen N, Hoffmann A, Seil R, Lor-bach O. Differences in fixation stability between spacer plate and plate fixator following high tibial osteotomy. Knee Surg Sports Traumatol Arthrosc. 2013; 21(1):82-9.
12. Schroter S, Gonser CE, Konstantinidis L, Helwig P, Albrecht D. High complication rate after biplanar open wedge high tibial osteotomy stabilized with a new spacer plate (Position HTO plate) without bone substitute. Arthroscopy. 2011; 27(5):644-52.
13. Spahn G. Complications in high tibial (medial opening wedge) osteotomy. Arch Orthop Trauma Surg. 2004; 124(10): 649-53.
14. Takeuchi R, Ishikawa H, Aratake M, et al. Medial opening wedge high tibial osteotomy with early full weight bearing. Arthroscopy. 2009; 25(1):46-53.
15. van den Bekerom MP, Patt TW, Kleinhout MY, van der Vis HM, Albers GH. Early complications after high tibial oste-otomy: a comparison of two techniques. J Knee Surg. 2008; 21(1):68-74.
16. Matsuda S, Miura H, Nagamine R, et al. Posterior tibial slope in the normal and varus knee. Am J Knee Surg. 1999; 12(3):165-8.
17. Yoshioka Y, Siu DW, Scudamore RA, Cooke TD. Tibial anatomy and functional axes. J Orthop Res. 1989; 7(1):132-7.
18. Staubli AE, Jacob HA. Evolution of open-wedge high-tibial osteotomy: experience with a special angular stable device for internal fixation without interposition material. Int Or-thop. 2010; 34(2):167-72.
19. Zaki SH, Rae PJ. High tibial valgus osteotomy using the Tomofix plate: medium-term results in young patients. Acta Orthop Belg. 2009; 75(3):360-7.
20. Staubli AE, De Simoni C, Babst R, Lobenhoffer P. TomoFix: a new LCP-concept for open wedge osteotomy of the medial proximal tibia: early results in 92 cases. Injury. 2003; 34 (Suppl 2):B55-62.
21. Dejour H, Walch G, Neyret P, Adeleine P. Dysplasia of the femoral trochlea. Rev Chir Orthop Reparatrice Appar Mot. 1990;76(1):45-54.
22. Giffin JR, Vogrin TM, Zantop T, Woo SL, Harner CD. Effects of increasing tibial slope on the biomechanics of the knee. Am J Sports Med. 2004; 32(2):376-82.