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Acute Correction of Varus Knee by Biplanar medial Opening-Wedge high tibial osteotomy and Fixation with Tomfix Plate

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Abstract

Background: *The biplanar medial opening wedge high tibial osteotomy (MOWHTO) a proper treatment method for symptomatic varus knee deformity allow adequate control of correction of varus knee, however, among its drawbacks is the tendency to decrease patellar height and increase the posterior tibial slope.*

Aim: *The aim of this work is to describe a technical ofbiplanar (MOWHTO) additionally, the described order of osteotomy fixation by tomofix plate regarding the accuracy of the planned correction and better control of the postoperative tibial slope.*

Patients and Methods: *A prospective study of 13 patients presented by varus knee deformity (8 male, 5 female) average age 31.69 years (17-45) who underwent the procedure between March 2016 and March 2017.The patients were assessed on the basis of pre and post-operative Knee and function scores, mechanical femorotibial angle (mFTA), posterior tibial slope angle (pTSA), range of motion and radiological evidence of healing of the osteotomy site. Follow up period was average12 months (12-18M).*

Results: *The knee score and functional score improved from the preoperative mean of 45, 41 respectively to mean postoperative was 75, 72 points .The average knee flexion was 115 (Range 100 –120) which at the final follow-up remained unchanged except one case complicated by limited full extension about 5 degrees. The mean preoperative Tibio-Femoral angle was 13.5º varus and postoperative was 3º valgus.*

Conclusion: *The biplanar High tibial Osteotomy allows preservation of posterior tibial slope, while correct the varus knee adequately.*

Keywords: *Varus knee, Biplanar medial opening-wedge high tibial osteotomy, Tomofix plate.*

Introduction

High tibial valgus osteotomy (HTO) is becoming an increasingly popular methodto correct varus malalignmentin patients with or without medial-compartment osteoarthritis(OA) of the knee. This joint preserving procedure plays a critical role within the continuum of care, as when performed precisely, it can delay or eliminate the need for joint replacement [1, 2] The goal of biplanar high tibial osteotomy to transfer the mechanical axis from medial to slightly lateral to the midline of the knee to decrease the load and subsequently delay osteoarthritis (OA) [3, 4, 5]

HTO surgery includes the lateral closed-wedge high tibial valgus osteotomy (CWHTO) [6] and medial open-wedge high tibial valgus osteotomy (OWHTO) [7]. There are many drawbacks for CWHTO including lateral-offset increases due to horizontalosteotomy and decreased bone block distal to the lateral tibial plateau. Shortening of the operated side lead to discrepancies in the leg may developed after CWHTO [8, 9] It also may complicated by delayed union at the osteotomy site after CWHTO because loss of opposition between the area on the proximal and distal fragments. So the alignment should be maintained long time until bone healing is achieved.

The TomoFix knee osteotomy system is based on the Locking Compression Plate system (LCP) and enables fixed angle stability between the screw and plate. This angular stability allows the stable fixation of an osteotomy aimed for early and safe mobilization in accordance with the AO principles [10].

The advantages of tomofix system were having rigid fixation, early range of motion, early weight-bearing [11]and maintenance of a normal preoperative posterior tibial slope; [12,13] but, it has the disadvantage of having more extensive skin irritation, prominent implant and soft tissue incision.

The purpose of this study was to evaluate of the biplanar medial opening wedge high tibial osteotomy (MOWHTO) additionally, the described technique of osteotomy fixation by tomofix plate regarding the accuracy of the desired correction and adequate control of the postoperative tibial slope

Patients and Methods

Between March 2016 and March 2017 thirteen e patients suffering from varus knee deformity were included in the prospective study were treated with Biplanar Open-wedge osteotomies and internal fixation by tomofix plate, they are 7 female and fivemal, Informed consent was obtained from the patient prior to the procedure. Demographic of the patient (age, gender, side, body mass index) was shown in table (1)

Table 1. *Demographic of the patient (age, gender, side, body mass index)*

	Age	Gender	BMI	Side
1	34	M	35	Bilat.
2	19	M	34	RT
3	30	F	28	RT
4	25	F	26.5	RT
5	18	F	26.5	Bilat.
6	45	M	27	Bilat.
7	39	M	28.5	LT
8	42	F	30	RT
9	17	M	29.5	LT
10	38	M	31.5	RT
11	40	M	20.5	LT
12	29	F	31	LT
13	36	M	29	RT
Total	**31.69**	**8M:5F**	**29**	**3Bilat. 6Rt.4Lt**

M: *Male.* ***F:*** *Female.* ***BMI:*** *Body mass Index. Bilat: Bilateral.* ***RT:*** *Right.* ***LT:*** *Left.*

Inclusion Criteria

Biplanar Open-wedge osteotomies of the medial proximal tibia for the treatment varus knee deformity with or without medial gonarthrosis (idiopathic or posttraumatic varus deformity of the proximal tibia)

Exclusion Criteria

Inflammatory arthritis or previous osteotomy of the same knee, Bi-compartmental (medial and lateral) OA, Fixed flexion contracture > 25°, restricted range of motion/fixed deformities (knee flexion < 90 degrees, ligamentous instability, Lateral tibial subluxation of more than 1 cm, medial compartment tibial bone loss of more than 2 or 3 mm.

Preoperative Planning

Preoperative mechanical femoral-tibial angles (mFTAs) were measured using weight bearing anteroposterior full-leg length radiographs that were taken while the patients were standing on both legs and the knee joint were in full extension. Target correction angle was measured at the point where the mechanical axis of the lower limb passed through the Fugisawa point, which is 62.5% from the medial tibial articular margin [14].

To determine the amount of required correction, a line is drawn from this point to the center of the femoral head and another to the center of the ankle joint. The angle created by these two lines indicates the amount of correction. [15]. Surgical procedure was identical in all cases and biplanar osteotomy was introduced according to the technique recommended by the AO principles[9]. Fig (3).

In all cases, an ascending and transverse biplanar medial open wedge osteotomy was proceed with

the use of insertion bone grafts, and fixation by locked plated was used for the stabilization of the osteotomy (Tomo Fix TM system, Synthes, Solothurn, Switzerland) Fig (1)

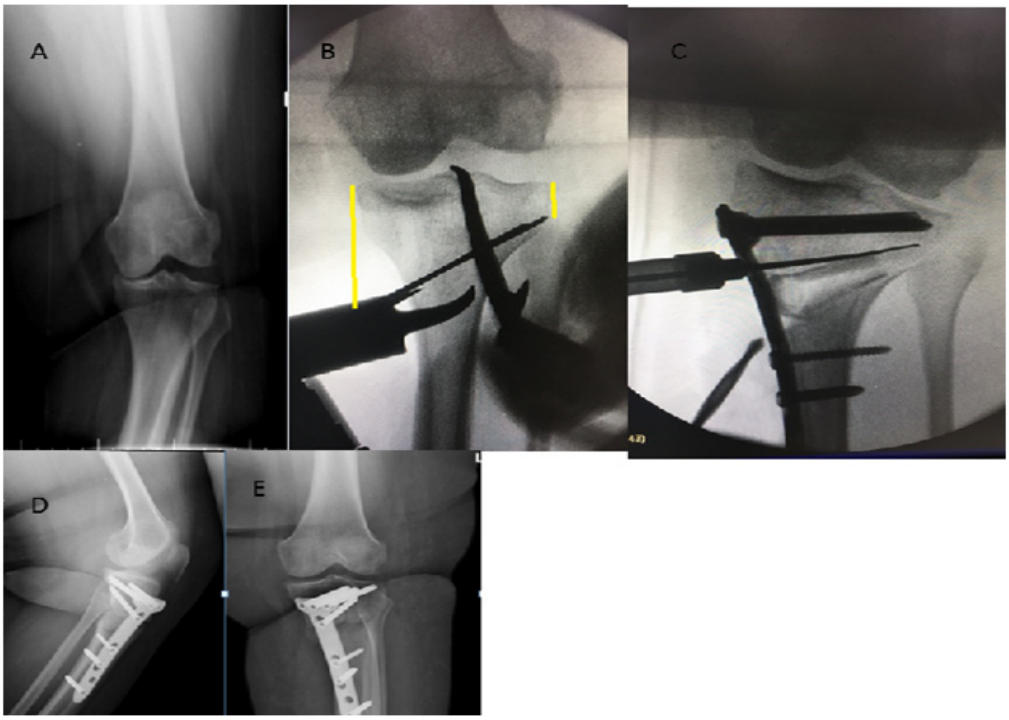


Fig 1. *A)AP standing view of knee with severe varus deformity B) Oblique k wire directed to head of the fibular without penetration to lateral cortex ,arrow line 1cm on lateral cortex from joint line, C) Left knee, medial view Locking tomfix HTO plate. Osteotomy gap filled with tricortical synthetic allograft D)Postoperative radiographic AP and lateral with correction of varus deformity Note thatMeasurement of posterior tibial slope has been made.*

Fig 2. *A,B) Photo view showing pre and postoperative biplanar osteotomy fixed by tomofix plate both knee , rt knee more than 1 y C) Postoperative X-ray right knee AP and LAT with overcorrection about 3º with bone healing at osteotomy side and rigid plate*

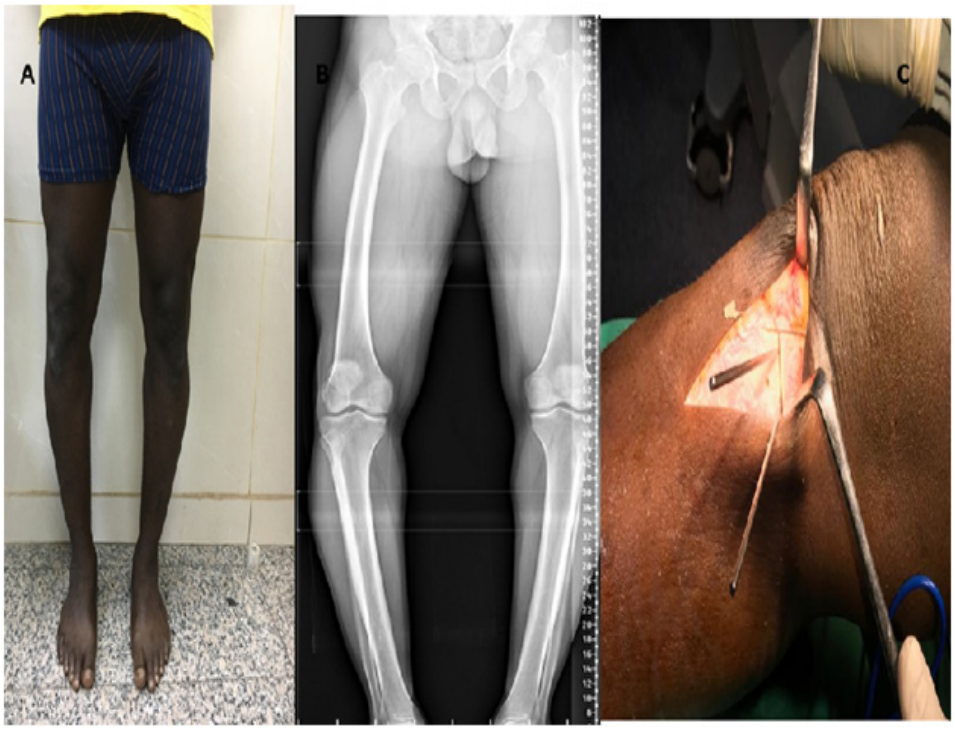
Surgical Technique

The patient was positioned supine on a radiolucent operating table. Mark the anatomic landmarks (medial joint line, upper border of pes anserinus, course of the medial collateral ligament, and tibial tuberosity) on the skin. A 6- to7-cm longitudinal incision mid way between the tibial tuberosity (TT) and the posteromedial border of the tibia was performed. The incision should start half inch distal to the joint line and extending to the pes anserinus tendons. A Hohmann retractor was inserted between the superficial medial collateral ligament and the posterior cortex of the tibia Fig (1).The distal end of the patellar tendon should beclearly visualized to allow planning of the anteriorly ascending and transversal cut (crossing point) of the biplanar osteotomy later on [16].

Biplanar Medial Opening Wedge Osteotomy

The ascending osteotomy cut parallel to the anterior cortex of the tibial shaft about one inch behind tuberosity of the tibial and transverse osteotomy cut parallel to tibial plateau to ensure good bony contact in the area of the ascending cut, after opening the osteotomy 110° to the transverse osteotomy [17] Fig (3). The upper border of the pes anserinus marks the starting point of the osteotomy. Under the c-arm image two parallel Kirschner wires are inserted from medial to lateral obliquely directed to the lateral hinge. The lateral hinged point is the upper end of fibular head so, do not penetrate the lateral cortex to preserve the hinged point [17]. The osteotomy cut the posterior half of the tibial cortex. After achieving biplanar the osteotomies, the gap was spread gradually by chisels and specially calibrated spreading device was used. When the measurement of the gap is accepted and equally to preoperative planned angle, the laminar spreader is inserted to save the realignment position until the cable line assess the mechanical axis by connecting the hip center to the ankle center passed through the centre of the knee laterally Fig(3) [14].

The osteotomy gap was filled with allograft or autograft tricortical strut mixed with autologous bone marrow or bone chips. Under fluoroscopy, insert the prepared plate medially and the shaft portion must be aligned with the tibial diaphysis to avoid anterior or posterior cortical overhang. Eight locked holes are used in theTomfix device, four proximal and four distal, of whichthree areunicortical. Conventional plate can be inserted firstly to contour the plate. An additional lag screw is applied through the first distal hole below the osteotomy afterproximal fixation;functionally compress the lateral hinged cortex of the osteotomy and eliminating any potential distraction or instability in this area [17] Fig (3)



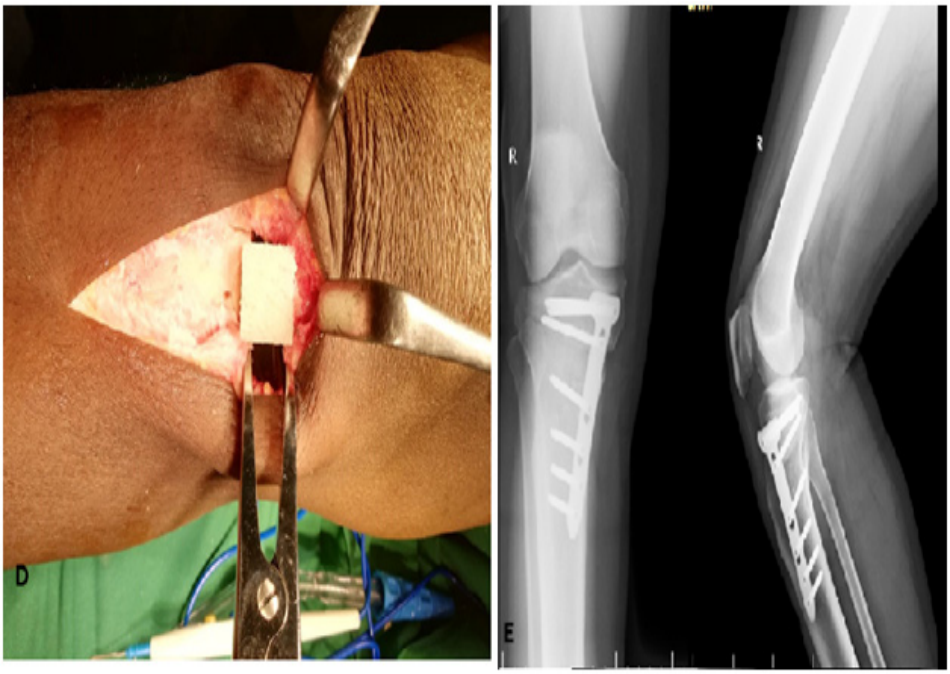


Fig 3: *A) Photo standing position showing Rt more varus knee. B) Full-weight-bearing long-leg standing (scanogram) anteroposterior (AP) radiographs showin severe varus knee on rtsideg .C)intraoperative photoshowin: Right knee, medial view.A 2.4-mm K. guidewire is placed in the medial cortex of the tibia, aimed toward the tip of the fibular head in a proximal and posterolateral direction, Both wires must run in parallel and aim towards the hinge point. D) Osteotomy gap filled with tricortical iliac bone crest allograft E) Postoperative X ray AP and LAT knee with corrected osteomy and tomofix plate, with slight increase of posterior tibial slope*

Post-Operative Care and Follow up Protocol

Post-operative ice bag and intermittent venous compression are recommended to relieve the swelling. The second day of surgery could be started continuous passive motion (CPM) associated muscle-strengthening exercises. Before six weeks partial weight bearing with walker allowed based on the amount of pain, although after six weeks full weight-bearing is permitted.

Final evaluations were performed by using American Knee Society knee and function scores, mFTAs, and changes in posterior tibial slope angle (pTSA). Posterior tibial slope was measured between the medial tibial plateau and the posterior tibial cortex [15].

Statistical Analysis

SPSS for Windows (version 17.0; SPSS, Chicago, IL) and GraphPad Prism 5 for Windows (version 5.01, GraphPad Software Inc., La Jolla, California, USA) were used forstatistical analyses designed to examine the data ascertainedin this study. For statistical evaluation ofclinical data including knee and function scores, a non parametric Mann–Whitney test was used. Accordingly P≤ 0.05 was considered significant.

Results

This scores revealed significant improvement of knee function at all follow-up. The knee score improved from the preoperative mean of 45 (range 32 – 60) to postoperative mean of 85 points (range 49 – 92). The mean preoperative functional scorewas 41 (range 32 – 58) and mean postoperative functional score was 72 points (range 52 – 93). The preoperative average knee flexion was 115 (Range 100 –120) which at the final follow-up remained unchanged except one case complicated by limited full extension about 5 degrees and may be due to increased tibal slope about 10degrees. The mean preoperative Tibio-Femoral angle (mechanical) was 13.5º varus (range 5–15) and mean postoperative Tibio-Femoral angle was 3º valgus (range 3–10)during weight-bearing and the final follow-up period (p ≤0.027*). Over correction was observed in one patient (Table 2).

Table 2. *Comparison of mean TFA and T Slope angles pre and postoperatively, weightbearing, ROM,Bonegraft ,time of union, and complication.*

	TFA		pTSA		ROM	F-Wt. Bearing	Time Union	B-Graft	Complications
	Pre	Post	Pre	Post					
1	7	1	5	7.2	100	8	4	Auto	
2	12.5	3	2.5	8	110	4	5	Synth	skin irritation
3	13	4	3	12	105	6	6	Synth	
4	15.5	6	5.4	9.7	120	5	3	Auto	
5	15	5	3.5	4	130	6	4	Synth	
6	20	7	4	5.5	120	7	5	Synth	
7	13.5	0	6	6.5	135	4	4	Auto	limited extension
8	10	-2	4	3	120	4	5	Synth	
9	10	1	5	3.5	115	5.5	6	Synth	
10	9.5	6	4.5	4	125	6.5	4.5	Synth	superficial infection
11	16	8	3	10	140	6.5	3.5	Synth	overcorrection
12	17	2	2.8	9	125	5.5	6	Synth	
13	16	1	5.7	6.7	130	4.5	5	Synth	
Total	13.37	3.06	4.03	6.57	107±12	5.48	4.68		
	P:0.027*		P:0.036*		P:0.039	0.039*	0.042*		

TFA:*Tibio-Femoral angle*, **pTSA:** *posterior tibial slope angle,* **FW:** *Full Weight,synth:synthetic*

The change of pTSA was 4 º preoperatively, to 6.5º post operative (p <0.036) which indicates better posterior tibial slope maintenance.The time of bone union at 4.68 months with average (3-6 M) after osteotomy with correction maintained for all pateintss post-operative, except one patient had presented by delayed union at 5month improved by knee brace and follow up until bone healing. Finally, skin irritation attributed to the larger Tomofix plate, which occurred inone case. The mean time to full weight-bearing was 5.48 W (range 4-8weeks). One superficial wound infection occurred which was treated successfully with appropriate antibiotics

Discussion

The current study demonstrate that acceptable correction of the mFTA was achieved by biplanar (MOWHTO) and fixation by TomoFix plate, Further more, pTSAs were better maintained which not affect the patellar height, and the complication rate was lower.

The other studies reported that the corrected angle of mFTA between 6º and 14 º with good clinical outcomes. Over correction where the femurtibial angle greater than 15 º appeared to be excellent clinical results but the patient not satisfied cosmetically. Undercorrection was associated with more failure procedure [18]. Other study also recommends over correction of the femortibial angle [19]. Hernigou et al., on the contrary, reported that an over correction of more than 6° is associated with progressive of articular degeneration andan under-correction is presented with poor satisfaction of patient and increase the symptoms of the medial compartment osteoarthritis [20].

Pape et al. [6]academic studies on a 30-subject clinical trial, where proceed by open wedge-HTO by using a spacer plate or plate fixator, and follow up to assess the fixation after 2-year period by radiostereometric analysis (RSA). The authors reported that early mobilization is appropriate for plater fixation, and that spacer plate fixation should be prolonged for up to 8–10 weeks to avoid nonunion and/or failure of desired correction.

Staubli and Jacob [21] andZaki and Rae [22] reported of good bone healing without bone graft or substitute in a TomoFix plate group. Asada et al [11] 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. 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 occurred at 6.5 weeks (4.5-7 W) after surgery, one case delayed union after follow up of 6 month. Skin irritation related to the plate occurred in 1 case, a bone union was obtained at 3 months after surgery. Further more, the under-correction rate of mFTA was noted in one case as the patient has morbid obesity associated with varus 15 degree, so it was difficult to achieve an acceptable angle. The TomoFix plate enabled the corrections of deformities exceeding 20° [23].

Open wedge upper tibial osteotomy causes distalization and lateralization of the tibial tuberosity (TT), which decrease the patellar length as suggested by Goutallier et al. [16] using a mathematical method. While, Amzallag et al. showed that patellar height decreased more than 20% in one-third of patients after an OWHTO. Standard OWHTO is contraindicated in patients with patella baja or infera [24].

Some authors have reported that upper tibial osteotomy might change the in tibial slope. generally, tibial slope increases after open-wedge high tibial osteotomies and decreases after the closed-wedge type. [25]The increase in posterior tibial slope may disturb the corrected coronal plane [11] and could result in more tension on cruciate ligament and influence knee stability and kinematics.[26,27]Changes to the tibial slope mightalso progress to early osteoarthritis

In the present study, a change in slope of 6.57° was observed in 13 cases pTSA was slightly higher at the final follow-up, which was presumed to be due to adequately maintain the posterior tibialslope, the opening ratio of the anterior to posterior gap should be 1 to 2 [21].So the knee should be extended after osteotomy to achieve and maintain this ratio.

The under-correction in the frontal plane in the cases of severe varus deformity increased posterior tibial slope, as shown by Asada et al [11] However, maintenance of posterior tibial slope l in the sagittal plane was simple 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.

The current study was used bone graft in all cases between three patients autogenous and the other tricortical synthetic grafts. Gaasbeek et al evaluated the site of osteotomy during plate removal after MOWHTO using TomoFix fixation and TCP filler [28]. They observed that TCP was absorbed and the new bone was completely remodeled and incorporated into the native bone. Autogenous iliac bone graft should be considered asa good option in patients who are at risk of nonunion such as smokers and obese patients [28]

There was no screw loosening or implant failure in this study whereas the TomoFix plate is a locking plate. Never the less, 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. On the other hand skin irritation in one case due to prominent implant and subcutaneous inflammation.

Limitations of the current study require consideration. In particular, this study is limited by small number of cases, and short follow-up period. This study shows that stable fixation using a TomoFix plate for biplanar open wedge HTO produces better clinical and radiologic outcomes and minor complication.

Conclusion

The biplanar OWHTO using the TomoFix system in which a transverse cut is combined with a second ascending cut behind the tuberosity results in corrects axial malalignment without changing patellar height or the posterior tibial slope. Accurate preoperative planning and a meticulous surgical technique with the use of rigid stable implants can minimize the complication rate.

References

[1] Hofmann AA, Kane KR. Total knee arthroplasty after high tibial osteotomy. Orthopedics. 1994; 17 (9): 887-90.

[2] Keene JS, Dyreby JR Jr. High tibial osteotomy in the treatment of osteoarthritis of the knee: the role of preoperative arthroscopy. J Bone Joint Surg Am. 1983; 65 (1): 36-42.

[3] Maquet P. 1985; The treatment of choice in osteoarthritis of the knee. Clin OrthopRelat Res. 192: 108-12.

[4] Coventry MB (1973): Osteotomy about the knee for degenerative and rheumatoid arthritis. J Bone Joint Surg Am.; 55 (1): 23-48.

[5] Akamatsu Y, Koshino T, Saito T, Wada J (1997): Changes in osteosclerosis of the osteoarthritic knee after high tibial osteotomy. ClinOrthopRelat Res.; 334: 207-14

[6] Pape D, Kohn D, van Giffen N, Hoffmann A, Seil R, Lorbach O (2013):. Differences in fixation stability between spacer plate and plate fixator following high tibial osteotomy. Knee Surg Sports Traumatol Arthrosc.;21 (1): 82-9.

[7] Brinkman JM, Lobenhoffer P, Agneskirchner JD, Staubli AE, Wymenga AB, van Heerwaarden RJ (2008): Osteotomies around the knee: patient selection, stability of fixation and bone healing in high tibial osteotomies. J Bone Joint Surg Br.;90 (12): 1548-57.

[8] van den Bekerom MP, Patt TW, Kleinhout MY, van der Vis HM, Albers GH (2008): Early complications after high tibial osteotomy: a comparison of two techniques. J Knee Surg.; 21(1):68-74.

[9] Lobenhoffer P, Agneskirchner JD (2003): Improvements in surgical technique of valgus high tibial osteotomy. Knee Surg Sports Traumatol Arthrosc.; 11 (3): 132-8

[10] www.depuysynthes.com/ifu

[11] Asada S, Akagi M, Mori S, Matsushita T, Hashimoto K, HamanishiC(2012): 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.;20 (3): 571-8.

[12] Brinkman JM, Luites JW, Wymenga AB, van Heerwaarden RJ (2010); Early full weight bearing is safe in open-wedge high tibial osteotomy. ActaOrthop. 81 (2): 193-8.

[13] Niemeyer P, Schmal H, Hauschild O, von Heyden J, Sudkamp NP, Kostler W.(2010) 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 radio graphic findings. Arthroscopy.;26 (12): 1607-16.

[14] Fujisawa Y, Masuhara K, Shiomi S (1979): The effect of high tibial osteotomy on osteoarthritis of the knee. An arthroscopic study of 54 knee joints. OrthopClin North Am.; 10 (3): 585-608.

[15] Rossi R, Bonasia DE, AmendolaA(2011): The role of high tibial osteotomy in the varus knee. J Am AcadOrthop Surg.; 19 (10): 590-9.

[16] Goutallier D, Delepine G, Debeyre J (1979): The patella-femoral joint in osteoarthritis of the knee with genu varum. Revue de Chirurgic Orthopedique;65: 25-31.

[17] Noyes FR, Barber SD, Simon R(1993): High tibial osteotomy and ligament reconstruction in varus angulated, anterior cruciate ligament-deficient knees: a two- to seven-year follow-up study. Am J Sports Med.; 21 (1): 2-12.

[18] Rudan JF, Simurda MA (1990): High tibial osteotomy. A prospective clinical and roentgeno graphic review.ClinOrthop 251–256.

[19] Ivarsson I, Myrnerts R, Gillquist J (1990): High tibial osteotomy for medial osteoarthritis of the knee. A 5 to 7 and 11 year followup. J Bone Joint Surg Br 72: 238–244

[20] Hernigou P, Medevielle D, Debeyre J, Goutallier D (1987): Proximal tibial osteotomy for osteoarthritis with varus deformity. A ten to thirteen-year follow-up study. J Bone Joint Surg Am 69: 332–354

[21] Staubli AE, Jacob HA(2010): Evolution of open-wedge high-tibial osteotomy: experience with a special angular stable device for internal fixation without interposition material. Int Orthop.; 34 (2): 167-72.

[22] Zaki SH, Rae PJ. 2009: High tibial valgus osteotomy using the Tomofix plate: medium-term results in young patients. ActaOrthop Belg.;75 (3): 360-7.

[23] Ozalay M, Ozkoc G, Circi E, et al (2008): The correlation of correction magnitude and tibial slope changes following open wedge high tibial osteotomy. Knee Surg Sports Traumatol Arthrosc;16:948-951.

[24] Amzallag J, Pujol N, Maqdes A, Beaufils P, Judet T, Catonne Y. (2013): Patellar height modification after high tibial osteotomy by either medial opening-wedge or lateral closing-wedge osteotomies. Knee Surg Sports TraumatolArthrosc; 21:255-259.

[25] El-Azab H, Halawa A, Anetzberger H, Imhoff AB, Hinterwimmer S. (2008): The effect of closed-

and open-wedge high tibial osteotomy on tibial slope: A retrospective radiological review of 120 cases. J Bone Joint Surg;90: 1193-1197.

[26] Lustig S, Scholes CJ, Costa AJ, Coolican AJ (2013): Parker DA. Different changes in slope between the medial and lateral tibial plateau after open-wedge high tibial osteotomy. Knee Surg Sports TraumatolArthrosc; 21: 32-38.

[27] Dejour H, Walch G, Neyret P, Adeleine P. Dysplasia of the femoral trochlea. Rev Chir Ortho pReparatriceAppar Mot. 1990; 76 (1): 45-54.

[28] Gaasbeek RD, Toonen HG, van Heerwaarden RJ, Buma P (2005);. Mechanism of bone in corporation of beta-TCP bone substitute in open wedge tibial osteotomy in patients. Biomaterials. 26 (33): 6713-9

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