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ORIGINAL ARTICLE

Treatment of Severe Varus Deformity in Primary Total Knee Arthroplasty using Metal Augment

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ABSTRACT

Background: Osteoarthritic knee with varus deformity is by far the commonest indication for total knee replacements in adults. Management of bone defects in severe varus deformity in primary TKR is still a challenge for orthopedic surgeons. Various techniques are available to compensate for bone defects in primary TKR including lower tibial resection, cement filling, autologous bone graft, allograft, wedges or augments and custom implants. So, we aimed to evaluate functional outcome of metal augmnets for management of tibial bony defect in primary TKR. **Methods:** A prospective study was conducted in Orthopedic Surgery Department, Faculty of Medicine, Zagazig University in the period between April 2020 and June 2022 involving 16 patients with 18 knees who underwent primary TKR due to osteoarthritis with severe varus deformity and tibial bone defects. All cases were followed up for a minimum of 24 months post operatively. **Results:** Degree of deformity significantly decreased from 23.56±3.94 to 5.12±1.62. FD significantly decreased from 19.62±6.85 to 1.87±0.74. ROM significantly increased from 64.06±17.81 to 108.12±9.81. Pain score significantly increased from 16.25±5.19 to 42.93±6.63. Walking score significantly increased from 12.5±4.25 to 38.75±8.85. AIDS score significantly increased from -6.87±2.63 to -1.01±0.358. Proximal medial tibia angle significantly increased from 67.62±3.79 to 90.0±0.0. KSS significantly improved from pre to post except 1 case still poor KSS after intervention. 87.5% of cases had no complications. **Conclusions:** Metal augments can be considered as a simple and effective method for the treatment of tibial bony defect in primary TKR.

Keywords: Varus Deformity; Total Knee Arthroplasty; Metal Augment

INTRODUCTION

Osteoarthritic knee with varus deformity is by far the commonest indication for total knee replacements in adults. TKA is considered now one of the most popular operation done worldwide in the treatment of end stage osteoarthritis .Although it provides excellent long term results in patients with end-stage osteoarthritis (OA), management of bone defects in severe varus deformity in primary TKA is still a challenge for orthopedic surgeons [1].Varus deformity is defined by any preoperative tibiofemoral angle less than naturally occurring anatomic valgus. Severe varus means varus knee deformity of more than 20 degrees (i.e. with tibiofemoral angle of more than 15 degrees of varus as measured on standing long film) [2].This deformity includes many components which may be isolated or combined together as: cartilaginous and erosive wear, ligamentous disorders or bone defect [2].

The development of asymmetric varus instability medial compartmental bone and cartilage imparts a varus moment of the joint. The varus moment combined with the attendant periarticular

inflammation associated with arthritic process ultimately results in pathological fibrosis and contracture of the medial collateral ligament (MCL), which is also worsened by medial osteoarthritic overgrowth pressing outwards from the joint on the ligament causing its relative shortening .Eventually, the effect of contracture of the MCL is a fixed varus deformity. Simultaneously, adaptive elongation changes in the lateral collateral ligament (LCL) and capsule and result in attenuation of these lateral soft tissue structures [3].

Ligament balancing of a severely deformed knee is the essence of a successful Total knee arthroplasty (TKA). Even in knees with minimal deformity, some ligament releases are necessary [3].

Bone defects involving tibial side are frequently encountered in primary TKA. They are typically found on medial or posteromedial aspects because of the predominance of varus-deformed knee [4].There are various classification systems of bone defects that are mainly based on size, severity, and location of the defects that enable accurate preoperative planning for management, predict outcomes, as well as provide guidelines on treatment and rehabilitation [4].

Various techniques are available to compensate for bone defects in primary TKA including Translation of the component away from the defect, lower tibial resection, cement filling, autologous bone graft, allograft, wedges or augments and custom implants [5].Management of bone defects during TKA is critical to obtain well balanced, aligned knee with longevity. In general, defects <5 mm are filled with bone cement or effectively eliminated with a lower tibial resection. If the defect depth is 5-10 mm, it can be filled with bone grafts. Metal augmentation can be used for defects deeper than 10 mm [6].Rand stated that a major advantage of metal wedge augmentation was the potential for excellent load transfer to the bone. Wedge augmentation produced strains more closely resembling the nonaugmented construct in the medial proximal region. Block augmentation produces strains similar to the wedge augmented and nonaugmented constructs but consistently lower than in the same region. Tensile strains were significantly reduced medially/proximally for centralized loads with the block augmented compared with those for the nonaugmented construct. There was no statistically significant reduction of compressive strains or shear strains proximally for either augment when compared with the nonaugmented case. For all treatments, distal strains were significantly greater than proximal strains. The presence of an augment slightly alters the bone stress in different locations. Metal augmentation should be customized to achieve full contact with the cortical bone to ensure better stress transfer and thus reduce the risk of bone resorption by stress shielding and bone-cement failure [7].The results of primary TKR with metal augmentation were satisfactory. Metal augmentation can be considered as a simple effective method for the treatment of tibial bony defect in primary TKR [7].

We hypothesized that metal augments is superior to other options used for management of severe varus in primary TKR regarding early weight bearing, longevity and patient satisfaction.

This study aim was to evaluate functional outcome of metal augments for management of tibial bony defect in primary TKR

METHODS

This study is carried out in Orthopedic Surgery Departments, Faculty of Medicine, Zagazig University in the period between April 2020 and June 2022 and all cases were followed up for a minimum of 24 months post operatively. The study was approved by

ethical committee of Faculty of Medicine, Zagazig University (IRB number: 6285-22/7/2020).

A prospective study was conducted involving 16 patients with 18 knees who underwent primary total knee arthroplasty due to osteoarthritis with severe varus deformity and bone defects. (Fig. 1)

Inclusion criteria:

Patient who fulfil criteria of varus deformity with bone defect in knee with osteoarthritis with Primary osteoarthritis in severe varus, Posttraumatic osteoarthritis with varus knee or Osteonecrosis.

Exclusion criteria:

Patient with active infection or Neuromuscular as poliomyelitis were excluded from the study.

The group of patients included 5 males (31.25%) and 11 females (68.7%), the mean age at time of surgery is 59.5 (range was from 49 to 70 years). Six patients had the right knee replaced, eight patients had the left one, while two patients had bilateral total knee replacement. All patients had flexion knee deformity. 14 knees had mild flexion deformity (less than 15˚) while 4 knees had moderate flexion deformity (15˚ - 30˚). The prostheses used in this study were cemented; Fixed bearing posterior stabilized (PS) in 17 knees, and constrained condylar knee in 1 patients.

Patient assessment:

[A] Clinical assessment: It included a detailed history, general examination and local examination (Deformity, Instability, Range of motion & Complete neurovascular examination of the affected limb).

[B] Radiological examination and planning: Routine radiographic assessment included

Long film weight bearing A-P radiographs: Identifying as well as quantifying the degree and apex of the deformity, Mediolateral osteophytes, Unusual anatomic variations (abnormal bowing, very small or very large intra-medullary canal), Preoperative planning (anatomical and mechanical axes, cuts and components size), Bone defects (size, site, containment, shape and slope).

Lateral radiographs: Approximate size of the components , Site of bone deficiency (anterior, posterior or whole plateau), Anterior and posterior femoral or tibial osteophytes, loose bodies, abnormal bowing of bones.

Skyline view at 30 degrees flexion: for patellar maltracking

Preoperative patient preparation:

Two units of blood were prepared for each patient, but their use was according to the individual situation. Preoperative hydration: one liter Ringer's solution at the operation morning. All the patients received a prophylactic antibiotic (Ceftriaxone 1g /24 hours 24 hours preoperative and continued for 5 days postoperative). Low molecular weight heparin was routinely used for prophylaxis against deep venous thrombosis; it was usually started the evening (12 hours after the operation) and continued for 2 to 3 weeks postoperative (40 I.U. once daily) according to the activity of the patient.

The protocol of limb preparation was as follows: It is started in the night before surgery after the patient was advised to have a shower. Followed by cleaning with soap and water followed by a topical antiseptic. Then draping the whole limb with a sterile towel till the time of surgery on the following day. Shaving: Better avoided, to avoid skin abrasions. Done only in hairy persons. Involve skin area along the planned incision with three cm clearance area on either side. This step is done just before entry to the operating room, while the patient is still in the induction room.

Operative technique:

Combined spinal-epidural anesthesia was used in all patients. *The medial*

para-patellar arthrotomy was the only approach, used in all cases.

Metal Augments: This is the used technique in our thesis. Augment were used in all 18 cases, (3) cases half block and other (15) cases by wedges according to defect geometry. After the proximal tibial cut is made at 10 mm depth from the unaffected tibial condyle, tibial surface is prepared to accept the tibial base tray. (Fig. 2).

The sclerotic base of the defect is cut to expose a flat, cancellous bony surface, and the concave, irregular defect is converted to a flat one by minimal bone removal with a saw. The tibial bone defect is then assessed (Fig. 3). A cutting guide for the block is assembled, and a matching bone resection carried out (Fig. 4). Care must be taken not to over resect the bone, since the tibial blocks should be inserted in a tight manner. The trial tibial component with the augment and intramedullary stem is assembled and inserted and a trial reduction is done, verifying alignment, stability and patellar tracking. After lavage, the real components are assembled and cemented. (Fig. 5)

The patients were followed up as follow:

- Removal of drain after 48 hours, removal of staples after 21 days.
- Regular follow up of patients every two months in first year and every 3 months later was done in all cases.
- Follow up and score taking were done (post-operative, 6 weeks and 6 months).
- Follow up period: all cases were followed up for a minimum of 24 months post operatively. (Fig. 6)

Statistical analysis:

Data collected throughout history, basic clinical examination, laboratory investigations and outcome measures coded, entered and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version20.0) (Statistical Package for the Social Sciences) software for analysis.

RESULTS

Age was distributed as 61.37±5.40 with minimum 49 and maximum 70, BMI was 25.87±4.16 and female were majority with 68.8% (Table 1). Majority regard pathology was OA with 93.8%, and regard site 12.5% (2 cases) were bilateral and 14 cases were unilateral with 87.5% and only one case did previous knee surgery with 6.3% (Table 2). All defects were uncontained peripheral tibia and all approaches were MPPA, regard implant type majority were PS with 94.4% and only one case was LCCK and regard type of augment majority were Wedge with 94.4% and only one case was half block (Table 3).Degree of deformity significantly decreased from 23.56±3.94 to 5.12±1.62. FD significantly decreased from 19.62±6.85 to 1.87±0.74 (Table 4). ROM significantly increased from 64.06±17.81 to 108.12±9.81. Pain score significantly increased from 16.25±5.19 to 42.93±6.63. Walking score significantly increased from 12.5±4.25 to 38.75±8.85 AIDS score significantly increased from -6.87±2.63 to -1.01±0.358. Stair score significantly increased from pre to post (Table 5). Proximal medial tibia angle significantly increased from 67.62±3.79 to 90.0±0.0 (Table 6). KSS significantly improved from pre to post except 1 case still poor KSS after intervention (Table 7). 87.5% of cases had no complication (1 case had Pin tract infection on drain site and 1 case had Superficial wound infection for 3 weeks).

Table (1): Demographic data distribution for studied group (N=16)

Age	**Mean± SD**	**61.37±5.40**	
	Median (Range)	**61.0 (49-70)**	
BMI	**Mean± SD**	**25.87±4.16**	
	Median (Range)	**25.0 (20-34)**	
		N	**%**
Sex	**Female**	**11**	**68.8**
	Male	**5**	**31.3**
	Total	**16**	**100.0**

Table (2): clinical characters and history data distribution for studied group (N=16)

		N	%
Pathology	**OA**	**15**	**93.8**
	RA	**1**	**6.3**
Site	**Bil**	**2**	**12.5**
	LT	**8**	**50.0**
	RT	**6**	**37.5**
Previous knee surgery	**No**	**15**	**93.7**
	Yes	**1**	**6.3**
	Total	**16**	**100.0**

Table (3): clinical characters and history data distribution for studied knees (N=18)

		N	%
Type of defect	**Un contained peripheral tibia**	**18**	**100.0**
Approach	**MPPA**	**18**	**100.0**
Implant	**LCCK**	**1**	**5.6**
	PS	**17**	**94.4**
Type of augment	**Half block**	**1**	**5.6**
	Wedge	**17**	**94.4**
	Total	**18**	**100.0**

Table (4): Degree of deformity pre and post distribution and FD pre and post distribution

	Pre	Post	Paired t	P
Degree of deformity	**23.56±3.94**	**5.12±1.62**	**15.014**	**0.00****
	Pre	**Post**	**Paired t**	**P**
FD	**19.62±6.85**	**1.87±0.74**	**7.357**	**0.00****

Table (5): ROM, pain score, walking score, AIDS score, and stairs score pre and post distribution

	Pre	Post	Paired t	P
ROM	**64.06±17.81**	**108.12±9.81**	**11.954**	**0.00****
	Pre	**Post**	**Paired t**	**P**
PAIN	**16.25 ±5.19**	**42.93±6.63**	**12.586**	**<0.001**
	Pre	**Post**	**Paired t**	**P**
WALKING score	**12.5±4.25**	**38.75±8.85**	**13.024**	**0.00****
	Pre	**Post**	**Paired t**	**P**
AIDS	**-6.87±2.63**	**-1.01±0.358**	**3.450**	**0.004***
	Pre	**Post**	**Sign**	**P**
Stair	**0 (0-15)**	**40 (30-50)**	**18.635**	**0.00****

Table (6): Proximal medial tibia angle pre and post distribution

	Pre	Post	Paired t	P
Proximal medial tibia angle	**67.62±3.79**	**90.0±0.0**	**23.599**	**0.00****

Table (7): KSS score pre and post distribution

			Pre	Post	Paired t/ sign	P
KSS score			**23.93±8.59**	**86.06±5.77**	**27.009**	**0.00****
KSS score	**Excellent**	**N**	**0**	**10**		
		%	**0.0%**	**55.6%**		
	Good	**N**	**0**	**6**	**42.0**	**0.00****
		%	**0.0%**	**33.3%**		
	Fair	**N**	**0**	**1**		
		%	**0.0%**	**5.5%**		
	Poor	**N**	**18**	**1**		
		%	**100.0%**	**5.5%**		
Total		**N**	**18**	**18**		
		%	**100.0%**	**100.0%**		

Figure (1): Preoperative AP and lateral weight bearing view x ray of a patient with severe varus knees

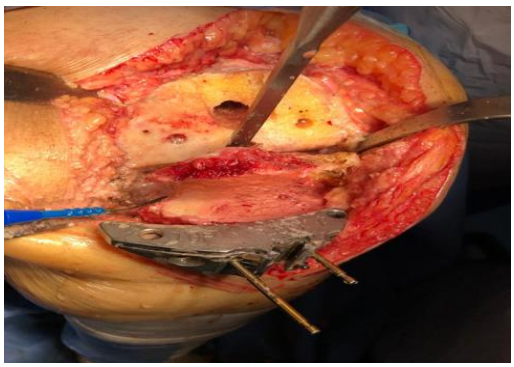

Figure (2): Tibial surface is prepared to accept the tibial base tray

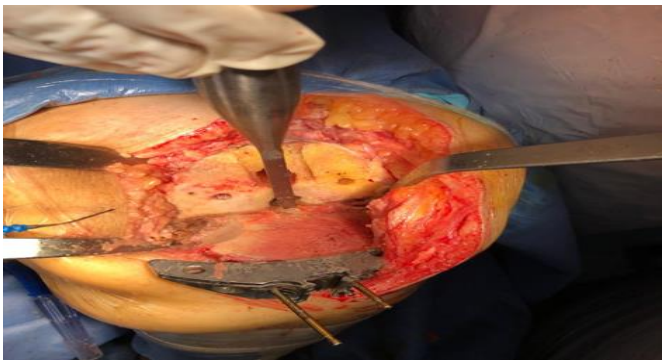

Figure (3): Assessment of tibial defect after tibial cut

Figure (4): A cutting guide for the block is assembled, and a matching bone resection carried out

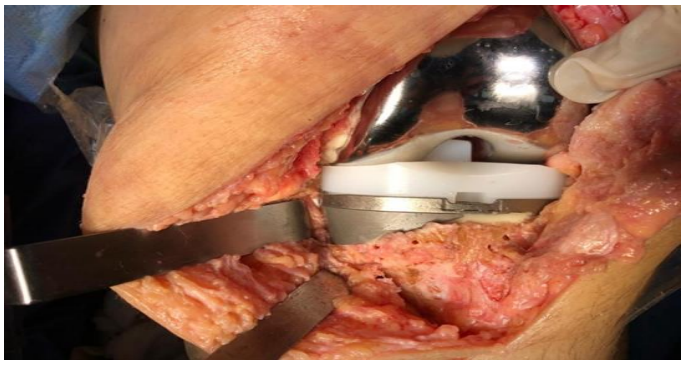

Figure (5): The real components are assembled and cemented

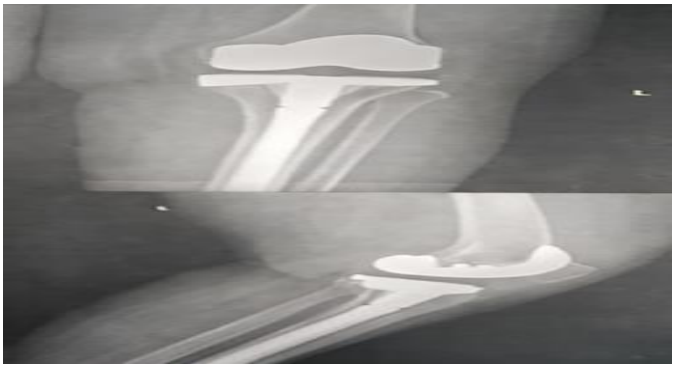

Figure (6): Final Follow up after two years (AP and lateral views)

DISCUSSION

Varus deformity is predominantly the most common deformity in candidates for total knee arthroplasty. Obtaining a well-positioned and stable prosthetic construct with restoration of the normal mechanical axes of the limb and joint line have been shown to have an important bearing on the final outcome of knee replacement operations [8]. Managing bone defects in severe varus deformity is of great importance in getting well balanced TKR [9].Various treatment options have been proposed for dealing with these bone defects. The alternatives include increasing the resection depth, reconstitution of the defect with bone cement with or without reinforcing screws, reconstitution of the defect with autograft or allograft bone, custom implants, and the use of metal augmentation [10].The use of metal augments in managing bone defects have a lot of advantages making them an appropriate solution. Metal augments provide multiple customization intraoperatively. Tibial asymmetrical defects do not need further bone resection to make a symmetrical bed to place the components. This allows preservation of bone stock and avoids damage further soft tissue damage [10].Kharbanda et al. [11], Iwase et al. [12] and Abdeldayem et al. [13] used

the same resection technique we used in our study (The lateral femoral condyle and the lateral tibial condyle were used as the reference for distal femoral resection and for tibial resection respectively). In Sachiyuki et al. [14] study tha patients were divided into 2 groups (one group with no defects and primary TKR without metal augmentation was done and the second group with bone defects and augmentation by metal augments was done). Pre-operative KSS in group with defect was 50 (30–70) and became 80 (65–90) after TKR with metal augment .In Abd El Hafeez et al. [15] study .they used different options in dealing with defects. 14 knee salvageable defect,13 knee cheating cut, 1 knee ignore defect,, 6 knees with bone graft ,6 knees with augment 2 half block and and 4 wedge. Pre-operative KSS was 30.2±15.0, the post-operative KSS was classified to 2 groups, the first group which uses bone graft was 92.1±8.9 while the second groups with metal augment usage was 90.3±8.78.This slight difference in the score might be noticed because those patients reconstructed by the metal augments had much more severe deformity and defects compared by the bone grafted defects. They recommend using bone graft in patients with medial plateau defect of 5 to 10 mm while they recommend using metal augments in defects more than 10mm. Another study that recommended the usage of metal augment is Abdeldayem et al. [13]. In this study the recommend the use of metal augments in managing bone defects in both primary and revision knees.

The present study had some limitations. First, the follow-up period was relatively short (all cases were followed up for 2 years postoperative). Second, small sample size (only 16 patients with 18 knees were involved). Lastly, lack of comparison between different options can be used for management of tibial bone defect in primary TKR.

Inspite of the mentioned limitations the study provides eventual support for the use of metal augments for management of bone defects in severe varus deformities due to less bone resection, being technically easier and better patient satisfaction, there were many concerns regarding their use in total knee replacement as tibial interface and the augments may experience loosening, disassociation, and fretting.

For future studies we think the short-term results should be confirmed by long-term follow-up. In addition more studies should be performed to compare different options available for management of severe varus deformities.

CONCLUSIONS

For the minimum 2-year follow-up, primary TKR with a metal augment produced satisfactory results, and it can be regarded as an easy and efficient way to treat tibial bony defects in primary TKR.

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