

Dome versus Chevron 1st distal metatarsal osteotomy for treatment of mild congruent adult hallux valgus

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ABSTRACT

INTRODUCTION: Hallux valgus is a lateral deviation of the great toe. It is a common and complex foot deformity. Radiologically, it is defined as hallux valgus angle (HVA) which angle between first metatarsal and proximal phalanx of big toe $>20^\circ$ and intermetatarsal angle (IMA) which is angle between first and second metatarsal bone of $>9^\circ$. These two angles are very important, not only for the diagnosis of the disease but also for selecting the type of surgery suitable for it. Hallux valgus can be treated conservatively; however, surgical intervention is indicated in some cases. Many surgical techniques have been used, but none has gain full satisfaction.

OBJECTIVE: Is to study the effectiveness of Dome surgical intervention and compare it to Chevron's clinically and radiologically in adult patient with mild hallux valgus.

METHODS: A prospective, randomized controlled study was conducted at Al-Kindy Teaching Hospital in Baghdad from January 2011 to July 2013. All patients who were over the age of 30 years and have mild hallux valgus were enrolled into two groups. Patients in the first group have been treated by dome technique, while those in the second have been treated by Chevron technique. Clinical and radiological outcomes were assessed in both groups through follow up for 3 months.

RESULTS: Twenty four feet of 19 patients were evaluated. Mean age was 50.3 years. Women to men ration were 8.5:1. In the dome technique, the mean preoperative AOFAS was 46.6, with inter-metatarsal angle (IMA) 12° and hallux valgus angle (HVA) 33° , while in the postoperative AOFAS it was 81.3, with IMA 7° and HVA 14° , and 92.3% satisfactory results. In the chevron technique, the mean preoperative AOFAS was 42.1, with IMA 12° and HVA 32° while in the postoperative AOFAS it was 77.4, with IMA 7° and HVA 15° and 81.8% of satisfactory results.

CONCLUSION: Dome technique is as effective as Chevron both clinically and radiologically for the treatment of mild hallux valgus.

Key words: Hallux valgus, Osteotomy, Dome, chevron.

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INTRODUCTION

Hallux valgus is a lateral deviation of the great toe with or without pronation resulting in increase intermetatarsal (IMA) and hallux valgus angles (HVA) more than the normal. It is not a single disorder, as the name implies, but a complex deformity of the first ray that frequently accompanied by deformity and symptoms in the lesser toes.¹

The upper limit of normal angle between the first and the second metatarsals is 9° while that of valgus angle which angle between first metatarsal and proximal phalanx of big toe is 20° . If the valgus angle of the first metatarsophalangeal joint exceeds 30 to 35° , pronation of the great toe usually results. With this abnormal rotation, the abductor hallucis,² which is normally

plantar to the flexion-extension axis of the first metatarsophalangeal joint, moves further plantarward. The genesis of this deformity is made up of extrinsic and intrinsic factors.³ The conservative treatment is of a palliative nature, alleviating the symptoms but not correcting the deformity; accordingly, surgical treatment would be indicated in painful cases when conservative treatment fails.⁴ Hallux valgus is divided into mild (HVA $\leq 40^\circ$, IMA $\leq 13^\circ$), moderate (HVA $>40^\circ$, IMA $>13^\circ$) and severe (HVA 41- 50° , IMA 16- 20°).¹

Hallux valgus is more common in women, with genetic predisposition. In 70 % of patient, positive family history of this deformity can be elucidated. Genetic susceptibility, rheumatoid arthritis, cerebral palsy, etc are important intrinsic risk factors for development of hallux

valgus. Wearing of shoes with high heel and narrow toe box is one of the most important extrinsic risk factors.⁵

Countless surgical techniques are reported in literatures, yet no single one has gained full satisfactory results for all cases.⁶ As a result it falls to the orthopaedist to indicate the best technique according to the anatomical variations, length of the first metatarsal, degrees of hallux valgus deformity, presence or absence of metatarsophalangeal joint arthrosis and first ray hypermobility. Tightness of Achilles tendon has founded to be of no significant in this decision.⁴

Dome and Chevron procedures are used to treat mild cases of hallux valgus by osteotomising the distal part of first metatarsal bone. Both carry the same effectiveness and risk of osteonecrosis of the head of 1st metatarsal bone;⁷ however, dome is simpler procedure and needs shorter time. Dome is not a popular procedure among Iraqi orthopaedicians. By this study we aimed at evaluating the effectiveness of dome technique in comparison to chevron technique in treatment of mild hallux valgus.

METHODS

Setting of the study: This is a prospective, clinical randomized controlled study, conducted at Al-Kindy Teaching Hospital in Baghdad over 30 months from January 2011 to July 2013.

Inclusion criteria: Any patient who was over 18 years of age and diagnosed as having mild hallux valgus at the consultancy orthopaedic department at Al-Kindy Teaching Hospital and advised for corrective surgery due to failure of conservative treatment was enrolled in this study. For sake of arrangement of the work at the hospital, we had included only those patients who had visited the consultancy department on every Sunday morning during the period of the study. Hallus valgux was defined as lateral deviation of the great toe with his or her weight bearing foot antero-posterior view radiograph showed a hallux valgus angle (HVA) of $>20^\circ$ and intermetatarsal angle (IMA) of $>9^\circ$.

Exclusion criteria: Patients with moderate and severe hallux valgus, which were defined as HVA $>40^\circ$, or IMA $>13^\circ$, had been excluded from this study. To minimize the risk of infection on the results of surgery, patients with diabetes mellitus or any other disease that may affect, di-

rectly or through its treatment, the immune system were excluded. Osteoarthritis, rheumatoid arthritis and non-congruent hallux valgus were excluded from the study as they need specific surgical intervention, joint fusion for the first two and soft tissue release for the third. Patient below the age of 18 years was also excluded to avoid the effect of growing epiphyseal plate on the results.

Randomization: Patients who fulfilled the inclusion criteria where randomized into two equal groups. Patients were numbered sequentially according to their priority of presentation at the consultancy department. Those who were labelled with odd numbers were allocated in the first group to have Dome surgery, while those who were labelled with even numbers were allocated in the second group to have Chevron surgery. If both feet of a patient were included in the study we consider it as if they are for two patients, the right side is counted first.

Primary endpoints: Patients were followed up every month for 3 months postoperatively. We used two parameters to assess the results in both groups; **the first** is the satisfaction scale questionnaire of the American Orthopaedics Foot and Ankle Society (AOFAS).⁸ (see [Table 1](#)) this scale provides a score for eight factors, from zero to 100 points, related to hallux valgus, such as: pain, limitation of activity and of movement, type of footwear used, presence of calluses and first ray alignment. We considered values ≥ 70 points as being satisfactory, while values < 70 points was considered unsatisfactory. **The second** parameter is the calculation of both HV and IM angles radiographically every 2 weeks for 3 months.

Procedure: We evaluated 24 feet of 19 patients. Before doing the surgery, the aim of the study with details about the procedures going to be used and their expected complications were explained thoroughly to the patients and we obtained their written signature on a consent form.

SURGICAL TECHNIQUES

Dome osteotomy: Preoperatively after obtaining full medical history, conducting physical examination and observing plain weight bearing foot x-ray (antero-posterior, Lateral, and oblique), we plan for the site and size of osteotomy. The operations were made under general anaesthesia with full aseptic technique by using butadiene solution starting from the knee. By applying

rubber type tourniquet above knee we secured bloodless field.

Through dorso-medial approach a 5-6 cm incision was made; medial and parallel to tendon of extensor hallucis longus (EHL). Start 2-3 cm proximal to MTP joint extends distally to the proximal inter-phalangeal joint. Superficial dissection incises deep fascia in line with the incision; EHL and dorsal digital branch of the medial cutaneous nerve were retracted laterally.

After deep dissection, medial Capsulotomy and bunion resection we exposes the first metatarsal bone seeking to correct the deformity by multiple holes as a curve of dome about 1-1.3 cm proximal to articular surface of head of 1st metatarsal bone by multiple drilling holes with 1.5 mm drill pit size in dome (crescent) manner.⁹ Then the bone is osteotomised by small curve osteotome to produce dome shape (See Figure 1) correction of deformity.

Fixation is made by 2 mm k-wire, the area is washed with normal saline. After that the tourniquet is removed and good homeostasis is secured followed by capsulorrhaphy with 1.0 vicryl suture. After suturing of the skin by silk 2 Zero, the wound is dressed and a short platform backslap is applied at 90 degree ankle position. (See Figure 2) the operative time of this procedure takes about 20-30 minutes.

Chevron osteotomy: The same perioperative preparations of Dome surgery which were mentioned in the first paragraph of this section were applied for patients undergoing Chevron technique.

We use a medial approach with a medial 5-6 cm incision, fascia is incised, then the capsule is opened to resect the bunion. After exposure of the first metatarsal bone, we put 1.5 mm k wire about 1-1.3 cm from the articular surface toward 5th metatarsal head to ensure the shifting direction of osteotomy. Correction of deformity is tried by chevron osteotomy of the 1st metatarsal bone with a small oscillating saw of a 5 mm blade. Fixation is done by 2.7 headless screws. Then the area is washed with normal saline. After that the tourniquet is removed and good homeostasis is secured followed by capsulorrhaphy with 1.0 vicryl suture. After suturing of the skin by silk 2 Zero, the wound is dressed and a short platform backslap is applied at 90 degree ankle position. The procedure takes about 60-90 minutes to be completed.

Table 1: Hallux Metatarsophalangeal-Interphalangeal Scale of the American Orthopaedics Foot and Ankle Society (AOFAS) Score

Pain (40 Points)	Points
None	40
Mild occasional	30
Moderate daily	20
Severe Almost always present	0
Function (45 points)	Points
Activity limitations	
No limitations	10
No limitation of daily activities such as employment	7
Limited daily and recreational activities	4
Severe limitation of daily and recreational activities	0
Footwear requirements	
Fashionable, conventional shoes, no insert required	5
Comfort footwear, shoe insert	3
Modified shoes or brace	0
MTP joint motion (dorsiflexion plus plantarflexion)	
Normal or mild restriction (75° or more)	10
Moderate restriction (30°-74°)	5
Severe restriction (less than 30°)	0
IP joint motion (plantar flexion)	
No restriction	5
Severe restriction (less than 10°)	0
MTP-IP stability (all directions)	
Stable	5
Definitely unstable or able to dislocate	0
Callus related to hallux MTP-IP	
No callus or asymptomatic callus	5
Callus, symptomatic	
Alignment (15 points)	Points
Good, hallux well aligned	15
Fair, some degree of hallux malalignment observed, no symptoms,	8
Poor, obvious symptomatic malalignment	0
Total	100

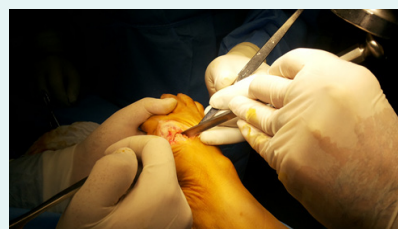


Figure 1: Curved Osteotomy after multiple small holes by drill.

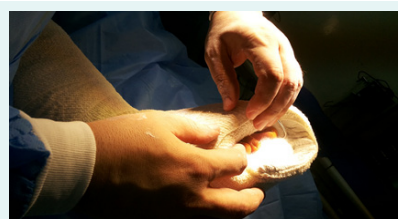


Figure 2: Short platform backslaps done.

In both technique: Measurement of hallux valgus and intermetatarsal angles pre and post-operatively are calculated radiographically in antero-posterior weight bearing view and at the same time in patients of both groups. Sutures removed at 2 weeks, backslap removed at 4 weeks, and k-wire removed at 6 weeks. In patients of both groups, we used ceftriaxone 1 g (mepha company) an hour before the procedure then at 6 hours post-operatively. Oral Cefixime 400 mg (mepha company) single daily dose is followed for 14 days.

Statistics: statistically we depend on Student T-Test and regard p-value <0.05 is significant.

RESULTS

Women are predominant in our sample; 17 women with 22 feet were included while we had only two men with two feet. The average age at the time of surgery was 50.3 years with a minimum of 32 years and maximum of 65 years. The side mostly affected was the left (14 feet) while the right side seen in (10 feet). (see table 2)

With dome technique we obtained 92.3% satisfactory results (11 feet) and 7.7% unsatisfactory results (1 foot). In this group the mean AOFAS score in the preoperative period was 46.6 points, climbing to 81.3 in the postoperative period. The preoperative mean IMA and HVA were 12° and 33°, dropping to 7° IMA and 14° HVA, respectively, in the postoperative period. For paired data showed a significant improvement

in the clinical (AOFAS) and radiographic aspects with this technique, ($p < 0.05$). (see table 3)

In the group of feet submitted to the chevron technique, the percentage of satisfactory results was 81.8% (10 feet) while unsatisfactory results represented 18.2% (two feet). In these feet the mean AOFAS score in the preoperative period was 42.1 points, climbing to 77.4 points in the postoperative period. And HVA were 12° and 32°, dropping to 7° IMA and 15° HVA, respectively, in the postoperative period. For both data shows a significant improvement in the clinical (AOFAS) and radiographic aspects with the use of chevron in this group of feet ($p < 0.05$).

When compared by the analysis, both techniques exhibited similar results in the clinical (AOFAS) and radiographic aspects, In the feet submitted to the dome procedure we found a slow consolidation in one case only, In the group submitted to chevron there were one patient complained of wound dehiscence and pain. We did not observe superficial or deep infections or reduced mobility of the metatarsophalangeal joint in the two techniques employed.

DISCUSSION

Symptomatic hallux valgus can be treated by several surgical techniques, yet no single one is ideal for all cases.⁶ Osteotomy of the first metatarsal is almost always required in all these surgical interventions for ray realignment.

In our study, we have found that hallux valgus is more prevalent in women than in men, in

Table 1 some demographic features of the participants in each group

Types of surgery	Side of the limb		Gender		Age in years	
	Left	Right	Female	Male	Range	Mean
Dome	8	4	11	1	37-65	51
Chevron	6	6	11	1	32-61	46.6

Table 2: Clinical and radiological comparison between patients in both groups

		AOFAS	p & t values	IMA	p & t values	HVA	p & t values
Group 1 (Dome)	Preoperative	46.6	$p < 0.00001$	12°	$p < 0.00001$	33°	$p < 0.00001$
	Postoperative	81.3	$T = 8.2860$	7°	$T = 7.2375$	14°	$T = 19.775$
Group 2 (Chevron)	Preoperative	42.1	$p < 0.00001$	12°	$p < 0.00001$	32°	$p < 0.00001$
	Postoperative	77.4	$T = 5.8485$	7°	$T = 10.4324$	15°	$T = 17.8480$

AOFAS: American Orthopaedics Foot and Ankle Society
IMA: Intermetatarsal angle
HVA: Hallux Valgus Angle

a ratio of 8.5:1. This result is consistent with that of Walter¹⁰ who shows that a women to men ratio is 9.5:1. Nary in his study¹¹ has explained that most of males who have hallux valgus have inherited the implicated gene from their mothers. This stresses on the major role of female gender on the development of this disease.

We have compared the effectiveness of both techniques clinically, by measuring the patient's satisfaction as assessed by AOFAS, and radiologically by measuring IM and HV angle pre and post-operatively. The overall clinical satisfaction in both groups was 87.5 %; a finding which is similar to that of Tonbul.¹² Mean AOFAS score of patients underwent dome procedure has raised from 46.6 preoperatively to 81.3 post operatively while in patients underwent chevron the raise was from 42.1 to 77.4 %; however, the difference in the improvement between the two groups was statistically non-significant.

Radiologically in the dome group, the mean preoperative IM and HV angles were decreased from 12° and 33° to 7° and 14° postoperatively. In chevron group, IM and HV angles were decreased from 12° and 32° preoperatively to 7° and 15° postoperatively. We could not find a study which compare between the radiological outcomes of dome and chevron procedures to draw a comparison with our results.

In comparison with chevron, Wilson, and other surgical technique, dome procedure is relatively not commonly practiced in the world. This can explain the difficulty in finding a research comparing the outcome of dome procedure to that of others. On reviewing the literatures, we find two articles the first is Klosok¹³ and the second is Kashiwa⁹ from Korea.

In our patients we observe good union rate in the patients who underwent dome technique, unlike Smith et al who reported delayed consolidation in six feet.¹⁴ Smith has performed proximal osteotomy; a procedure which expected to have relatively less complications in comparison to our technique of doing distal osteotomy. We think that these results can be attributed to the use of plate and screws in fixation of bone by Smith which means the need for doing multiple drilling in a small bone with more potential damage to the bone mass. We tried to overcome this danger by using k wire to preserve the bone mass.

Many researches^{5,16,17} and even textbook¹⁸ have described proximal dome shape or cres-

cent osteotomy, but description of distal dome shape metatarsal osteotomy is rather rare. This is because the proximal part of the bone is wider in diameter than the distal part and this makes doing the curve much easier especially for larger IMA.

The primary aim of our study was to compare the effectiveness of dome shape distal osteotomy to chevron, we need more studies to address not only the effectiveness of this procedure but also the early and late complications on a larger sample size so we can adopt this technique in our daily practice.

CONCLUSIONS

Dome shape distal osteotomy is as effective as chevron in treatment of mild congruent hallux valgus in adults.

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Abbreviation list: InterMetatarsal Angle (IMA), Hallux Valgus Angles (HVA), American Orthopaedics Foot and Ankle Society (AOFAS), Extensor Hallucis Longus (EHL),

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