OUTCOME OF MEDIOLATERAL DOME, CHEVRON AND LATERAL-BASED PROXIMAL TIBIAL CLOSING WEDGE OSTEOTOMY WITHOUT FIXATION FOR BILATERAL BLOUNT'S DISEASE

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ABSTRACT

Background: Studies assessing the outcome of corrective osteotomies without fixation in Blount's disease are scarce in literature.
Objective: We present our outcome with three types of osteotomies without fixation so as to increase the management options for surgeons especially in resource constrained settings as well as increase the literature on management options in Blount's disease.
Methods: This was a prospective study in which patients had chevron, mediolateral dome or lateral-based proximal tibial closing wedge osteotomies without fixation. Plaster of Paris back slab was then applied for 2 weeks, full cast for at least 6 weeks and hinged brace for 6 weeks. Measurement of correction and documentation of complications were done after cast removal and recurrence was assessed at one year.
Results: Mean range of varus correction was 22.13±9.94 (p<0.0001). Mean improvement in Drennan's angle was 24.18±3.94 (p <0.0001). Chevron osteotomy had 6.8% surgical site infection rate (p 0.110) and 9.1% knee stiffness rate (p 0.178). Three cases of nerve palsy were seen with two occurring in the wedge osteotomy group (p 0.206). Recurrence was 14.8% at one year. Statistically significant recurrence was noted in wedge osteotomies (p 0.031). Using Schoenecker's grading, 87.5% adjudged their surgeries as good, 9.4% as fair and 3% adjudged it poor. Logistic regression showed that no independent osteotomy type was a reliable predictor of good outcome at one year 95% Confidence Interval (CI).
Conclusion: Corrective osteotomies without fixation results in good outcome and patient satisfaction. No osteotomy type is superior to the other however; wedge osteotomy is associated with a significant recurrence rate.

Key words: Blount's disease, Dome, Chevron, Wedge, Osteotomy, Patients

INTRODUCTION

Blount's disease was first described by Erlacher in Germany in 1922 (1). However, it was Walter Blount's comprehensive description of this condition in the United States in 1937 that gave more understanding and credence to the condition (2). The aetiology of Blount's disease remains unknown but risk factors include: overweight children, early walkers (<1 year), Hispanic children and children of African/African-American decent. The prevalence of Blount's disease for Africa as a continent is unknown. However, South Africa has a prevalence of 0.03% (3). Blount's disease is broadly known to consist basically of two varieties- the infantile or early onset and the adolescent or late onset Blount's disease (4). Structurally, Blount's disease was initially considered to be just a frontal plane deformity (5). The features are now understood to be multiplanar and include a varus deformity of the tibia, internal tibial torsional deformity, proximal tibial procurvatum and depression of the medial tibial plateau. It is usually associated with disruption of the medial tibial physis with the potential of affectation of longitudinal growth (6). Langenskiold staged the disease entity into six classes based on progressively worsening structural deformity.

A variety of surgical treatment modalities have been described down the years- the bamboo osteotomy first described in Indonesia, the anterior posterior inverted 'U' osteotomy popularized by Ogbemudia in Nigeria, the single high tibial osteotomy, the double osteotomy described by Mc Carthy, the medio-lateral dome osteotomy, the wedge osteotomy, the Chevron osteotomy and the step cut "V" osteotomy amongst others (7-13). The choice of treatment generally depends on the age of the patient, the extent of deformity, the degree of limb discrepancy and the surgeon's experience (13). Although surgeons tend to stick with osteotomy types that are within their expertise, the chevron, dome and wedge osteotomies are the most widely used. Many surgeons prefer to use stabilization devices following corrective osteotomies in the form of plates, Kirschner wires or external fixators for the advantage of early weight bearing and obviating the risk of re-displacement of the osteotomy. The challenge of the cost of implants and other fixation devices such as ring fixators for patients within the context of a resource poor setting has made surgeons in such areas as ours to explore other alternatives of managing patients with Blount's disease. Studies assessing the surgical management of Blount's disease without fixation appear scarce in literature. The outcome of wedge, chevron and dome osteotomy using fixation devices such as compression plates, Kirschner wires and ring fixators have generally yielded satisfactory results (14-16). In this study, we present our experience using three types of osteotomies without the use of fixation devices so as to increase both the literature on management options in Blount's disease as well as the options for surgeons especially in resource constrained settings.

MATERIALS AND METHODS

This was a prospective study conducted in one of the tertiary hospitals in south east Nigeria. Patients were enrolled for the study from the orthopaedic clinics of our facility during the study period that spanned from October 2015 to September 2018 having obtained informed consent from the parents of the patients who were minors. The inclusion criteria for the study was Langenskiold grade iii, iv, v, vi and bilateral limb involvement. Langenskiold i and ii as well as unilateral Blount's disease were excluded from the study. Patients who met the inclusion criteria had their parameters recorded which included: age, gender, pre-operative varus angle, pre-operative Drennan angle and Langenskiold grades.

For each limb to be operated upon, patients were booked for dome, chevron or wedge osteotomies by picking a sealed envelope (containing one specific osteotomy type) from one group out of four groups of sealed envelopes. Each group of envelopes was marked with a specific Langenskiold grade corresponding to the four Langenskiold grades studied (iii, iv, v, vi); such that patients picked from the group of envelopes that corresponded to the Langenskiold grade of their limb. Each group of envelopes contained equal number of the three osteotomy types to be studied.

Surgical technique: All patients had standard surgical workup and preoperative planning to predict the size of the wedge and they had prophylactic antibiotic with ceftriaxone given at induction of anaesthesia. Skin preparation was done according to the hospital's protocol.

For all osteotomy types, a 5cm incision was made at the lateral aspect of the mid leg with subperiosteal dissection and removal of a 0.5cm segment of mid-fibular. Skin incision was closed using nylon 2/0 suture without fascia closure.

Hockey stick incision was used for wedge osteotomies, while lazy-S incision was used for the chevron and dome osteotomies. The proximal aspect of the fascia of the leg was split to avert the risk of compartment syndrome. Subperiosteal dissection to the proximal tibial metaphyseal region was done laterally for wedge and combined medial and lateral for chevron and dome. All osteotomies were sited distal to the tibial tuberosity with 2.5mm drill bit pre-drilling to outline the osteotomy. Osteotomy sizes for both the wedge and chevron were determined by preoperative planning guided by the varus angle. In wedge osteotomies, part of the wedge of bone taken was crushed and packed at the osteotomy site to aid healing, while in chevron group, the lateral wedge taken was relocated to the medial side. Dome osteotomies were done from the medial cortex to the lateral cortex in a semi-circular fashion. 20ml pulsatile normal saline irrigation was done for all wounds prior to closure. No fascial closure was done.

Immediate postoperative valgus overcorrection: Above knee Plaster of Paris (POP) back slab was then applied after sufficient padding with correction of the deformities to half the intended final range of correction so as to prevent vasospasm and nerve traction injuries. Correction was achieved by application of gentle palmar pressure on the back slab overlying the lateral aspect of the knee and counter opposing pressure on the back slab overlying the medial malleolar region and held in that position till POP back slab set. Distal vascular status was assessed over the dorsalis pedis and confirmed with a pulse oximeter over the ipsilateral hallux.

Subsequent care: Wound inspection for Surgical Site Infection (SSI) was done on the 5th post operative day while on the 14th post operative day, the POP back slab and sutures were removed along with application of full length POP which was manipulated to 5-10 degrees valgus over correction along with distal vascular status re-assessment. Patients were discharged on cast for at least 6 weeks following which casts were removed, final postoperative correction measured, assessment for knee stiffness and nerve palsy done as well as measurement of post op Drennan angles on knee radiographs. Hinged knee braces were then applied for 6 weeks. Weight bearing was guided by radiographic and clinical features of osteotomy healing.

One year later patients had re-measurement of varus or valgus angles and parent-patient satisfaction profile was assessed based on Schoenecker's grading system (17). Data was collated and analyzed using SPSS version 21.

RESULTS

A total of 128 corrective osteotomies were done on 64 patients with bilateral Blount's disease during the study period. The mean age was 9.14±2.75. There were 30 males and 34 females giving a male to female ratio of 1:1.1. The most predominant grade was Langenskiold IV seen in 75 (58.6%) limbs (Figure 1).

The mean preoperative varus angle was 29.86±10.80, while the mean preoperative metaphyseo-diaphyseal angle of Drennan was 28.56±5.36 (Table 1). Chevron osteotomy showed the highest number of cases of surgical site infection with three cases (6.8%) *p 0.110.* Four (9.1%) patients that had chevron osteotomies had knee stiffness (*p* 0.178), while two (4.7%) patients that had wedge osteotomies developed nerve palsies (*p* 0.206) as shown in Tables 2,3.

Table 1
F-test of preoperative variables

	Chevron	Dome	Wedge	*F**	P-value
Pre-op varus angle	29.98±11.17	30.14±8.97	29.47±10.13	0.052	0.950
Pre-op Drennan angle	28.33±5.84	28.64±5.13	28.07±4.74	0.127	0.881
Age in years	9.13±2.53	10.00±2.59	8.25±3.01	2.144	0.126

*F- ANOVA

Table 2
Complications and recurrence in the different osteotomy groups

Osteotomy type	No. of patients with complications	X^2	P-value
	Surgical site infection		
Wedge	1(25.0)	0.137	1.000
Dome	0	2.017	0.302
Chevron	3(75.0)	3.173	0.110
	Knee stiffness		
Wedge	1(16.7)	0.809	0.663
Dome	1(16.7)	0.744	0.663
Chevron	4(66.6)	3.087	0.178
	Nerve palsy		
Wedge	2(66.7)	1.506	0.206
Dome	0(0)	1.500	0.550
Chevron	1(33.3)	0.001	1.000
	Recurrence		
Wedge	11(25.6)	3.406	0.031
Dome	2(4.8)	1.500	0.550
Chevron	6(14.3)	0.001	1.000

Table 3

Complication rates across the osteotomy types

Osteotomy type	Surgical site infection	Knee stiffness	Nerve palsy	Recurrence	Total
Chevron	3 (6.8%)	4 (9.1%)	1 (2.3%)	6 (29.4%)	14
Dome	0 (0.0%)	1 (2.4%)	0 (0.0%)	2 (11.8%)	3
Wedge	1 (2.3%)	1 (2.3%)	2 (4.7%)	11 (58.8%)	15
Total	4	6	3	19	32

All groups showed significant improvements in the Drennan's angles ($p < 0.0001$) (Table 2). The post operative valgus angles when compared with the preoperative varus angles showed statistically significant improvements ($p <0.0001$) (Table 4).

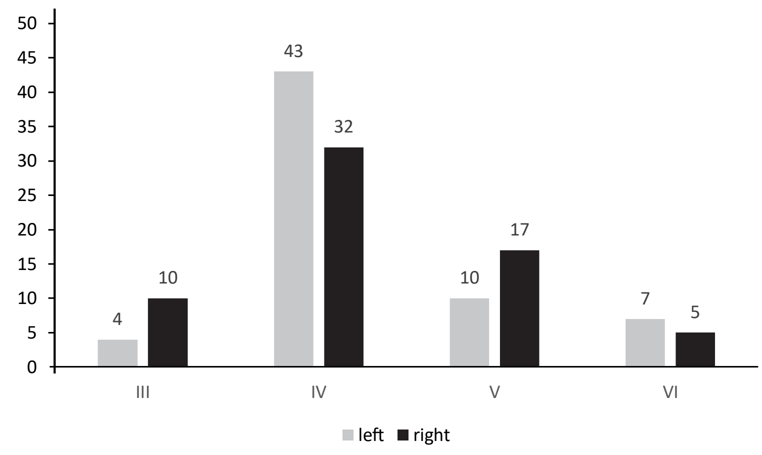
Table 4

Comparing pre and post-operative varus, valgus and Drennan's angle among the different osteotomy types

	Pre-operative varus angle	Post-operative valgus angle	T	P-value
All surgeries	29.86±10.80	7.73±1.86	16.593	<0.0001
Chevron	29.98±11.17	7.67±2.14	13.432	<0.0001
Dome	30.14±8.97	7.83±1.74	16.217	<0.0001
Wedge	29.47±10.126	7.70±1.726	14.671	<0.0001
	Pre-operative Drennan angle	Post-operative Drennan's angle	T	P-value
All surgeries	28.56±5.36	4.38±1.42	38.256	<0.0001
Chevron	28.33±5.84	4.51±1.42	28.303	<0.0001
Dome	28.64±5.13	4.43±1.40	32.179	<0.0001
Wedge	28.07±4.74	4.23±1.38	33.328	<0.0001

Figure 1

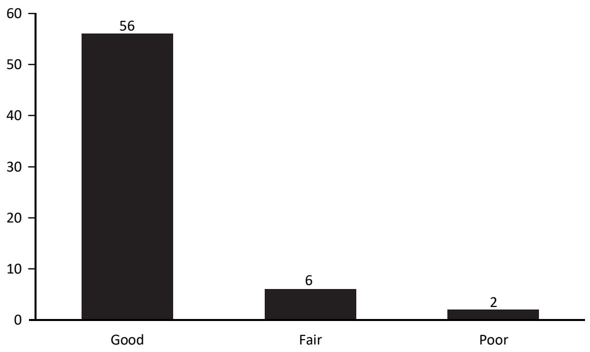
Langenskiold grades of the patients



At one year, 56 (87.5%) parents of patients using the Schoenecker's grading system adjudged their surgeries as good, 6 (9.4%) parents of patients adjudged it as fair, while 2 (3%) parents adjudged it to be poor (Figure 2).

Figure 2

Shoeneckers outcome assessment



Recurrence was noted in 19 limbs (14.8% recurrence rate). The recurrences were 11, 6 and 2 for wedge, Chevron and dome osteotomies respectively. Logistic regression analysis taking into cognizance age, gender, Langenskiold grade and osteotomy type done showed that no osteotomy type was a reliable predictor of outcome after 1year 95% Confidence Interval (CI) (Table 5) .

Table 5

Logistic regression for outcome predictors

Predictors of good outcome after one year	P-value	Odd Ratio	95% C.I. for EXP(B)	
			Lower	Upper
Gender*	.365	1.670	.551	5.058
Langenskiold grade ǂ				
Langenskiold grade III	.750	1.615	.084	30.876
Langenskiold grade IV	.828	.778	.081	7.479
Langenskiold grade V	.520	.463	.044	4.834
Osteotomy Type †				
Chevron	.247	1.966	.627	6.170
Dome	.014	7.391	1.488	36.716
Age in years	.107	.859	.713	1.034

Legends: *Female sex; † Wedge; ǂ Langenskiold VI

DISCUSSION

One hundred and twenty eight corrective osteotomies were performed on 64 patients during our study period. There was a slight preponderance of female patients presenting during the study period. While most orthopaedic literature appears to agree that Blount's disease tends to occur more in males, some studies in this part of the world have shown similar observations of more females than males during a study period (18,19). Since our study is not multicentre and lacks an epidemiological structure, a categorical conclusion on a changing gender preponderance in this part of the world cannot be made.

We note a general Surgical Site Infection (SSI)) rate of 6.25% across all osteotomy groups. There was no SSI in the dome osteotomy group whereas there were one and three for wedge and chevron osteotomy groups. Corrective osteotomies by convention fall in the category of clean surgeries. The presence of surgical site infections recorded may be due to the peculiarities of theatres in third world countries that seldom meet aseptic international standards. To our knowledge our index study is one of the few studies to document experience of corrective osteotomies without fixation or any form of stabilization as literature on this is rather patchy. While other studies in future may help shed light on SSI rates in corrective osteotomies without fixation in third world countries, it appears that the SSI rate in this study when compared to studies on the use of stabilization devices is much lower (20). From our study we note that the chevron osteotomy is associated with a higher Surgical Site Infection (SSI) rate when compared with other osteotomy types (*p* 0.110). We theorize that the medial and lateral dissections involved in relocating the wedge piece of bone may account for a more prolonged tissue handling time and by extension the higher predisposition to surgical site infection.

Our study also showed the highest rate of knee stiffness in the chevron osteotomy group with 4 (9.1%) in comparison to one each in the dome and wedge osteotomy groups (2.4% and 2.3% respectively). We generally attribute our cases of knee stiffness to the period of cast immobilization rather than to the osteotomy type in itself. Megahed (21) documented a greater than 5 degrees loss of range of motion in 3 out of 20 knees following proximal tibial osteotomies with Ilizarov ring fixators. This gives a rate of about 15%. Thus with a timed removal of cast, the rate of knee stiffness can be comparable with what is obtainable in the use of the ring fixators. We note a higher rate of knee stiffness amongst the chevron group possibly because most patients in this group required a slightly long period of cast immobilization of about 8 weeks.

We note two cases of nerve palsy in wedge osteotomy group in comparison to one case in the chevron group and none in the dome osteotomy group. One of the two cases in the wedge group had sensory loss over the dorsum and lateral part of the upper leg while one had foot drop which resolved after 6 months. Jeong *et al* (22) also documented a case of deep peroneal nerve palsy following opening wedge high tibial osteotomy. They attributed theirs to a protruding screw which was removed with eventual resolution of the nerve palsy in 9 months. We attribute our nerve palsies to traction injuries from retractors during the osteotomies. The possibility of compression of the common peroneal nerve against the neck of the fibular during palmar pressure around the lateral aspect of the knee while trying to get plasters to set cannot be excluded.

We found improvements in the varus angle ($p<0.0001$) and the metaphyseo-diaphyseal angle of Drennan across all osteotomy groups ($p<0.0001$). We note that across all osteotomies, the mean range of correction was 22.13 ± 9.94 degrees. This finding was comparable to the study by Burton and Hennrikus (23) who documented a mean correction range of 26 degrees using oblique complete closing wedge osteotomy with compression plating. We did not observe significant differences in the post-operative angles across the different osteotomy groups as all osteotomy types demonstrated significant improvements from the pre-op varus angles ($p<0.0001$).

We had 19 cases of recurrence (14.8% recurrence rate) across all osteotomy groups at 1 year. We defined recurrence in this study as re-occurrence of varus angle of >5degrees at 1 year. This was seen in 14.8% of limbs. This rate was also comparable to the study by Burton *et al* (23) who found a recurrence rate of 11%. Eamsobhana *et al* (24) found recurrence rates of 28.6% and 12.5% in the two groups of patients they studied. They defined their recurrence rates as varus deformities >10 degrees. In addition, they tested for recurrence at 4 years as against 1 year in our study. Despite setting our recurrence at 5 degrees, we note that our rates are not in complete deviance with other studies. We however note when comparing the osteotomy groups we studied, a statistically significant recurrence rate amongst the wedge group (p 0.031), while chevron and dome group showed recurrence rates of no statistical significance.

On the overall, Schoenecker's grading, 56 (87.5%) patients assessed their outcome as good, 6 (9.4%) patients described it as fair. Two (3%) patients felt their outcomes were poor. Five of the 6 patients in the 'fair' category had some documented knee stiffnesss, while the 2 patients in the 'poor' category had varus angles of 15 degrees at 1 year. Taking into cognizance parameters of age, gender and Langenskiold grade against the osteotomy type performed we note that no osteotomy group could reliably predict outcome at one year 95% Confidence Interval (CI). Thus no osteotomy type is superior to others.

Study limitation

This study is a single centre study with a relatively small sample size. Thus these findings may not depict what is obtainable across other centres in the African continent. Secondly, we were unable to demonstrate if recurrence was skewed in the direction of surgeries performed by surgeons with less experience with Blount's disease since it would have been near impossible to have all the surgeries done by a single surgeon within a tertiary health facility.

CONCLUSION

We conclude from our study that corrective osteotomies without fixation devices generally produces good range of varus correction with low complication rates that leaves parents and patients generally satisfied. It is thus a practicable option in resource constrained settings. In the absence of fixation, no osteotomy type demonstrates superiority to others. There is however a significant tendency for recurrence when the wedge osteotomy is used.

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