ORIGINAL ARTICLE

# W/M serrated osteotomy for infantile Blount's disease in Ghana: Short-term results

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## Abstract

**Purpose:** The W/M serrated high tibial osteotomy is a not frequently described surgical technique for simultaneously correcting the varus and torsional deformity in patients with Blount's disease. Without the need for internal fixation, this surgical treatment is well suited for developing countries. This study describes the short-term results of the bilateral and unilateral W/M serrated osteotomy in patients with infantile Blount's disease.

**Methods:** Between May 2008 and January 2013, 52 patients were treated with uni- (*n* = 22) or bi-lateral (*n* = 30) W/M serrated osteotomy of the proximal tibia due to a tibial varus deformity in two district hospitals in Ghana. Other causes than infantile Blount's disease were excluded from the analysis. Pre- and post-operative clinical and radiological measurements were done, and complications were monitored up to 12 weeks after surgery.

**Results:** Seventeen patients (five males, 12 females; mean age 4.9 [standard deviation: 2.10]) were included, which underwent a total of 25 W/M serrated osteotomies. The femorotibial angle was corrected from 34.1° ([mean] range: 6–68°) to − 7.1° ([mean] range: −28–5°). Only one patient had developed a wound infection, and all reached full consolidation.

**Conclusions:** The W/M serrated osteotomy seems a profitable alternative technique for treating the varus and torsional deformity in patients with Blount's disease in the circumstances of developing countries. The short-term outcomes are good and promising with a low complication rate and good consolidation. Long-term follow-up results of these patients are needed to observe possible complications.

**Level of Evidence:** IV, therapeutic case series.

**Key words:** Blount's disease, complications, infantile, osteotomy, tibia vara

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## Introduction

Blount's disease or tibia vara is characterized by tibial bowing, torsion, and beaking of the posteromedial proximal tibia and involves the epiphysis, physis, and metaphysis.[1-3]

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The etiology of infantile Blount's disease is probably multifactorial. Associations are found between Blount's disease and the Afro-Caribbean race, early walking age and obesity.[3-5] Genetic predisposition is suggested, and mechanical loading of the physis is often implicated.[4,6,7] On magnetic resonance imaging, a thicker layer of epiphyseal cartilage and increased height of the medial meniscus in the medial compartment is observed.[8,9] These macroscopic findings reflect the compensation mechanism of the medial



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down-sloping.[8,9] Histological analysis shows islands of densely packed hypertrophied chondrocytes, areas of acellular cartilage matrix, and abnormal clusters of capillaries resulting in necrosis of the physeal cartilage.[1]

The abnormal stress on the medial physis, causing growth inhibition, can be reduced by transferring the pressure to the lateral compartment of the knee.[4,6,7] Physeal growth in the medial compartment will be stimulated.[4,6,7] This pressure can be transferred by repetitive plaster correction into valgus or nocturnal splinting or one can opt for a high tibial osteotomy. Several osteotomies are described such as the medial based opening-wedge-osteotomy or dome and Chevron-type.[2,10] Since, all of these osteotomies require internal fixation of the bony fragments to allow proper consolidation a risk of implant infection exists. Besides the risk of implant infection, after proper consolidation, most of the implants have to be removed surgically. Furthermore, with these types of osteotomies, it is often challenging to correct the torsional component.

The tibial W/M serrated osteotomy, firstly described in 1995 by Khermosh *et al.*,[11] enables simultaneously correction of the varus component as well as the torsional deformity, without the necessity for internal fixation.[11,12] In the setting of developing West-African countries, where Blount's disease is reported frequently, W/M osteotomy could be an appropriate alternative for correcting the varus malalignment and tibial endorotation in suboptimal hygienic circumstances. In this study, early results of the high tibial W/M serrated osteotomy for the treatment of infantile Blount's disease performed in Ghana are presented.

## Materials and Methods

From May 2008 to January 2013, 52 patients were treated with a uni- ($n$ = 22) or bi-lateral ($n$ = 30) W/M serrated osteotomy of the proximal tibia due to a tibia vara deformity combined with tibial endorotation. Patients were treated in two district hospitals in Ghana. Seventeen patients with infantile Blount's are included for analysis. In this study, we are primarily interested in infantile Blount's disease. Therefore, other diseases resulting in tibial bowing are excluded, e.g. primary osteoarthritis, posttraumatic osteoarthritis, rickets, and late-onset Blount's or age >12 years [Figure 1].

Patients are clinically evaluated preoperatively by the operating surgeon on level of pain, instability, torsional deformity, and the intercondylar distance measured with a ruler between both medial epicondyles of the knee (implantable cardioverter defibrillator [ICD]). Weight-bearing radiographs are taken in the anteroposterior and lateral projections of the lower extremities in a standardized manner. The femorotibial angle (FTA) is measured by drawing a line through the longitudinal axis of the femur and tibia [Figure 2: Red lines]; the metaphyseal-diaphyseal angle (MDA)[1] is measured by drawing a line from the lateral edge of the metaphysis to the medial beaked edge of the metaphysis [Figure 2: Yellow lines] and a second line perpendicular to the longitudinal axis of the tibia; and the medial physeal slope (MPS) (angle between a medial and lateral line true the physis) [Figure 2: Green lines]. All cases are classified according to the Langenskiöld classification [Table 1].[13] This classification describes the six progressive roentgenographically visible stages that were originally described for the infantile type of Blount disease. This classification is based on a cascade of different degrees of epiphyseal depression and metaphyseal fragmentation of the proximal medial tibial epiphysis. The classification is used to aid diagnosis, to monitor the progression, and to guide treatment.

The osteotomies were performed by orthopedic surgeons from Ghana and from The Netherlands. Therefore, an anterior vertical incision was used for subperiosteal exposure of the proximal shaft of the tibia just below the tibial tuberosity. Care was taken to fully free the periosteum of the lateral cortex to make way for the lateral point of the distal part of the osteotomy. Along the lateral compartment, through the same incision, the proximal fibula was exposed, and an oblique fibular osteotomy was performed with an osteotome about 8 cm distal to the fibular head. An "M" shape was marked on the proximal tibia just distal to the pyhsis of the tibial tuberosity, creating three dentations on the proximal part and two dentations on the distal part [Figure 3]. The width of the proximal tibia determines the length and width of the dentations of the marked "M". To increase the stability of the osteotomy, the teeth had to be pointed (at least 90° or less). Drill holes were made at the points of the "M". An osteotome was used to connect the marks and to complete the osteotomy posteriorly. The distal parts of the serrations were disengaged anteriorly and replaced with a lateral shift of one tooth, preserving

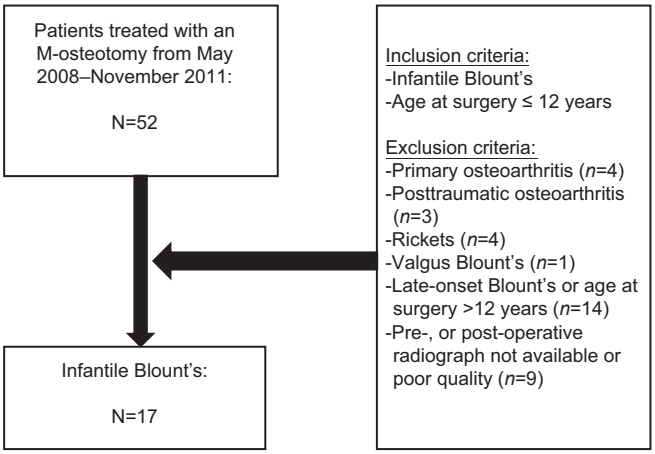


**Figure 1:** Flowchart: Inclusion and exclusion criteria

leg length. Thereafter, the tibia was re-engaged in the corrected position and derotated as desired [Figure 4]. The appropriate valgus correction was achieved by impacting or shortening the teeth in the desired position and lifting the medial side of the proximal tibia bloc. By creating pressure from the tibial shaft against the lateral cortex of the tibial head, the medial side of the head is lifted, and the medial joint space closed as far is possible. When the proximal medial bloc was not stable due to the ligament laxity, or when the osteotomy itself was not stable, a Kirschner wire was added for temporary fixation and directly removed when the cast was fully set. The periosteum was closed carefully contributing to the stability. Then, the skin was closed. Finally, a long-leg cast was applied in the correct rotation and valgus overcorrection.

After 12 weeks of plaster immobilization, consisting of 6 weeks unweight- and 6 weeks weight- bearing, all patients underwent radiographic evaluation of the final alignment using the MDA, MPS, and FTA, and consolidation. When appropriate consolidation is observed, the surgeon decided whether to remove the plaster [Figure 5]. Patients were clinically tested on stability of the correction and discharged from the hospital. Of all patients, a pre- and post-operative clinical photo was taken [Figures 6 and 7]. Most patients remained admitted to the ward during the 12 weeks of plaster immobilization.

Statistical analysis was performed using the statistical program SPSS® (Statistical Package for the Social Sciences, Chicago, IL, Version 21.0). Data were tested on normal distribution using the Kolmogorov–Smirnov test. The results were considered significant at $P < 0.05$.

## Results

Seventeen patients with infantile Blount's disease were included (five males, 12 females) with a mean age of 4.9 ± 2.10 years (range: 2–9 years). The Langenskiöld stage at time of surgery ranged from I to V [Table 1]. During the preoperative planning all patients had a torsional deformity,

**Figure 2:** Preoperative measured angles Red: femorotibial angle, Yellow: metaphyseal-diaphyseal angle, Green: medial physeal slope

**Figure 3:** Marking the "M"

**Figure 4:** Disengaging the osteotomy anteriorly

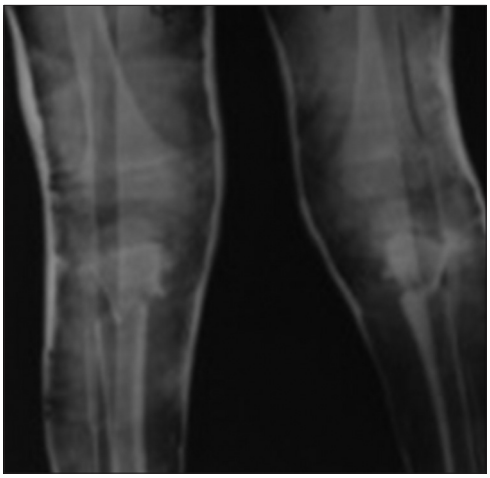

**Figure 5:** Postoperative anteroposterior radiograph

**Table 1: Patient characteristics with pre- and post-operative measured angles**

| | Patient number | Age (years) | Gender (female/male) | Langenskiöld | Side (left/right) | Preoperative | | | Postoperative | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | FTA | MDA | MPS | FTA | MDA | MPS |
| Bilateral | 1 | 3.0 | Male | I | Left | 59 | 38 | 43 | 2 | 2 | 43 |
| | | | | | Right | 56 | 25 | 45 | 5 | 5 | 45 |
| | 2 | 4.0 | Male | II | Left | 30 | 34 | 28 | −3 | 1 | 28 |
| | | | | | Right | 12 | 16 | 28 | −8 | 1 | 28 |
| | 3 | 3.0 | Male | I | Left | 40 | 17 | 49 | −10 | −18 | 49 |
| | | | | | Right | 30 | 16 | 48 | −4 | −15 | 48 |
| | 4 | 2.5 | Female | I | Left | 43 | 13 | 45 | −20 | 10 | 45 |
| | | | | | Right | 45 | 20 | 43 | 0 | 6 | 43 |
| | 5 | 3.0 | Female | II | Left | 32 | 14 | 43 | −12 | 12 | 43 |
| | | | | | Right | 32 | 28 | 46 | −4 | 6 | 46 |
| | 6 | 8.0 | Male | V | Left | 10 | 19 | 50 | −2 | 10 | 50 |
| | | | | | Right | 26 | 34 | 50 | −2 | 10 | 50 |
| | 7 | 5.0 | Female | II | Left | 30 | 24 | 12 | −4 | 0 | 12 |
| | | | | | Right | 34 | 18 | 0 | −6 | −10 | 0 |
| | 8 | 5.0 | Female | II | Left | 12 | 15 | 15 | −8 | 2 | 15 |
| | | | | | Right | 26 | 36 | 30 | 0 | 10 | 30 |
| Unilateral | 9 | 7.5 | F | IV | Left | 12 | 20 | 54 | −13 | −2 | 54 |
| | 10 | 3.0 | Male | I | Right | 39 | 18 | 52 | 5 | 6 | 52 |
| | 11 | 5.5 | Male | I | Right | 68 | 12 | 37 | −10 | 20 | 37 |
| | 12 | 7.0 | Female | V | Right | 30 | 30 | 55 | −12 | 2 | 55 |
| | 13 | 4.0 | Female | IV | Right | 68 | 50 | 58 | −28 | 4 | 58 |
| | 14 | 9.0 | Female | IV | Right | 40 | 50 | 42 | −7 | 2 | 42 |
| | 15 | 2.0 | Female | III | Right | 48 | 34 | 27 | −13 | 8 | 27 |
| | 16 | 6.0 | Female | V | Left | 25 | 30 | 40 | −8 | 20 | 40 |
| | 17 | 6.0 | Female | V | Left | 6 | 12 | 48 | −15 | 2 | 48 |

FTA=Femorotibial angle, MDA=Metaphyseal-diaphyseal angle, MPS=Medial physeal slope

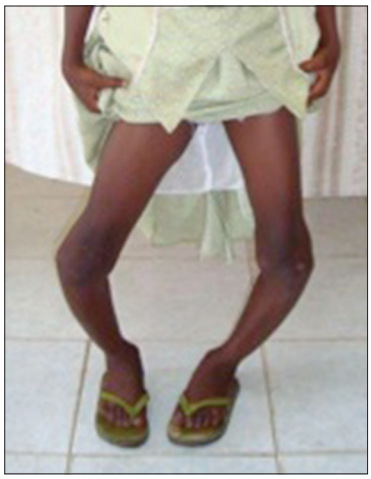

**Figure 6:** Preoperative clinical evaluation

**Figure 7:** Postoperative clinical evaluation after full consolidation

10 patients had subsequent pain in their knee, and three patients had collateral laxity problems. All patients underwent a W/M serrated osteotomy, of which eight procedures were bilateral (age [mean]: 4.2 ± 1.81 years) and nine unilateral (age [mean]: 5.6 ± 2.23 years) due to unilateral leg involvement [Table 1].

Because of normal distribution, a paired *t*-test was used to compare pre- and post-operative angles. The FTA and MDA were corrected from 34.1° (range: 6–68°) and 24.9° (range: 12–50°) to 7.1° valgus (range: 28° valgus – 5° varus) and 3.8° (range: −18 to + 20°) [Table 1]. No significant difference was found between the Langenskiöld stage Blount's disease at the time of surgery and the amount of correction. The MPS did not change after surgery, and the ICD was corrected to zero in all patients. Clinically, the rotational deformity has been reduced [Figure 5].

For seven patients, additional temporarily Kirschner wire fixation was performed due to inappropriate stability of the osteotomy. These wires were removed directly after the cast was fully set. During follow-up, only one patient developed a superficial wound infection which was treated with local care and healed well after several weeks. No other complications were reported, and all patients reached full consolidation, evaluated on plain radiographs.

## Discussion

In this study, the varus and torsional deformity in children, diagnosed with infantile Blount's disease, were successfully corrected using the W/M serrated osteotomy. After removal of the plaster, 12 weeks after surgery, all patients reached full consolidation. Only one patient developed a wound infection. No major complications were seen.

Complications after high tibial osteotomies described in literature are peroneal nerve palsy, nonunion, delayed union, malunion, compartment syndrome, deep venous thrombosis, osteomyelitis, hematoma, and infarction of the proximal tibia.[14,15] Compared to other types of osteotomies described in the literature requiring additional internal or external fixation such as opening- and closing-wedge, dome, spike, and oblique osteotomies, this study reported favorable results concerning the complication rate. A study by Cherkashin *et al.*[16] for example, revealed twelve pin tract infections out of 20 osteotomies among patients with infantile Blount's disease using an additional circular external fixator (Ilizarov apparatus).[16] Risk of infection after internal fixation without the use of an external fixated is reported lower. Huang *et al.*[17] performed 46 high tibial osteotomies using a locking compression plate for internal fixation and observed two deep infections which were treated with surgical debridement and external fixation.[17] The infection rate would probably be higher in the setting of developing countries. Because, the W/M serrated osteotomy does not necessarily require additional internal fixation the risk of infection is reduced to a minimum. One should take into account that besides suboptimal hygienic circumstances in an average district hospital in Ghana, patient-related factors affecting healings such as sickle-cell anemia and malnutrition are not uncommon among the Ghanaian population.

Only a few studies were conducted describing the W/M serrated osteotomy in patients with tibia vara deformities.[11,18] Hayek *et al.*[18] published their clinical results of thirteen W/M serrated osteotomies in eleven children with an average age of 3.6 years (range: 3.0–5.1) at time of surgery with a Langenskiöld stage ranging from II-IV. No complications were seen during or after surgery.[18] None of these patients redeveloped into a varus deformity after a mean follow-up of 8.0 years (standard deviation: 4.2).[18] Only one patient had difficulties during his normal daily activities because of occasional pain.[18]

After appropriate surgical correction of the varus malalignment in children with Blount's disease, it is not unlikely for the varus malalignment to reoccur. For example, Ferriter and Shapiro[19] conducted a study in which 37 children with Blount's disease were treated with closing-wedge, opening-wedge, and dome osteotomies with additional internal fixation. They corrected the varus deformity to an average of 9° of valgus (range: 5–20°). Up to 57% of the patients required one to four additional osteotomies.[18] Reoccurrence rate was increased for obese patients and patients over 4.5 years.[18] Another study conducted in Nigeria described a reocurrence rate of 15.1% after surgery which seems to be related to the preoperative severity of the varus.[9] Although the length of follow-up of our study is too short to observe a possible varus deformity to reoccur, previous studies suggest the W/M osteotomy is not inferior to other osteotomies with respect to the reoccurrence rate.

Unfortunately, this study was limited in patient numbers. Several cases of infantile Blount's had to be excluded because of pre- and/or post-operative missing radiographs [Figure 1]. One should keep in mind that collecting data in developing countries is challenging; radiographs can be lost or damaged since they are patient's property. Furthermore, it was not possible to measure the mechanical axis of the lower limb since only plain knee radiographs were taken. Fortunately, of all patients, clinical pre- and post-operative photographs were available and gave a good view of the clinical correction [Figures 6 and 7]. Most patients remained admitted to the ward during the 12 weeks of plaster immobilization which made it easier to replace the plaster of Paris (POP) if insufficient. The goal of this study was to describe the early radiological results and complication rate following the W/M serrate osteotomy, and no clinical outcome parameters besides the ICD were recorded.

One of the patients excluded from this study was initially diagnosed with bilateral Blount's at the age of 2 years; however, one leg spontaneously healed over time, and the other leg underwent surgery at the age of 9 years. Spontaneous healing is described in several studies.[5,15,18] Ferriter and Shapiro[19] noted two cases with bilateral Blount's in whom one leg improved on its own, whereas the other limb worsened over time and needed surgery. Laville *et al.*[15] observed that in one out of three patients, presenting with Langenskiöld stage I Blount's disease, the deformity resolved spontaneously. Shinohara *et al.*[5] found that eighteen patients out of 24 with stage 2–3 Blount's disease, and an MDA of >11° spontaneously healed after 6 years.

Future research should be focused on the underlying cause of Blount's. It has been suggested Blount's is caused by excessive compressive forces on the medial portion of the proximal tibia, causing an alteration of cartilaginous chondrocytes structure and function which results in growth inhibition.[8] Factors such as obesity and early walking seem to contribute to the expression of the disease, and overweight will lead to a higher reoccurrence rate and failure of conservative treatments.[19,20] However, in the literature, studies are mainly published on the obese Afro-American population, whereas our patients were more likely to be underfed. In addition, the disease is commonly seen among siblings, which suggests there is a genetic underlying cause.[21,22]

## Conclusion

The W/M serrated osteotomy could be considered acceptable alternative technique for treating the varus and torsional deformity among patients with infantile Blount's disease in the circumstances of developing countries. The short-term outcomes are good and promising with low complication rates and good consolidation. Long-term follow-up results of these patients are needed to observe possible long-term complications. Better understanding of the etiology might prevent early reoccurrence of the deformity.

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**Conflicts of interest**
There are no conflicts of interest.

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