



Adolescent Blount disease in obese children treated by eight-plate hemiepiphyodesis

Sekiz-plağı hemiepipifizez ile tedavi edilen obez çocuklarda adolesan Blount hastalığı

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Objectives: The aim of this study is to evaluate the outcomes of eight-plate (Orthofix) use during hemiepiphyodesis operation for growth modulation in obese children with adolescent Blount disease.

Patients and methods: Six limbs of five consecutive patients who underwent lateral proximal tibial eight-plate (Orthofix) hemiepiphyodesis were evaluated. The body mass index (BMI) was >30 and the severity of the deformity was in Zone III according to the Mielke and Stevens definition. The mechanical medial proximal tibial angle (MPTA) and the mechanical axis deviation (MAD) were measured preoperatively, postoperatively, and at last follow-up. The outcome of the procedure was established by the degree of tibia vara correction degree at final plate removal or skeletal maturity.

Results: Mean age of the patients and mean BMI at the time of surgery was 13 years (range 12 to 14) and 33.5 kg/m² (range 31 to 36), respectively. Patients were followed for an average of 22 months (range 13 to 31). Preoperative and last follow-up mean values for MPTA were 81 and 80 degrees, respectively. Outcome of the procedure showed two extremities demonstrated progression of the tibia vara (mean of 6.5 degrees), two extremities had no correction of the deformity, and the remaining two extremities showed minimally improvement (mean 3 degrees). The procedure failed to correct the tibia vara in all extremities and all patients were scheduled for an osteotomy to treat the deformity.

Conclusion: We do not recommend the use of a tension band plate hemiepiphyodesis (eight-plate, Orthofix) to treat severe adolescent Blount disease in obese children.

Key words: Adolescent; Blount; hemiepiphyodesis; eight-plate; obesity.

Amaç: Bu çalışmada adolesan Blount hastalığı olan obez çocuklarda büyümenin düzenlenmesini sağlamak için yapılan hemiepipifizez ameliyatlarında sekiz-plağı (Orthofix) kullanımının sonuçları değerlendirildi.

Hastalar ve yöntemler: ‘Sekiz-plağı (Orthofix)’ ile lateral proksimal tibial hemiepipifizez yapılan beş ardışık hastanın altı ekstremitesi değerlendirildi. Hastaların tümünde vücut kütle indeksi (VKİ) >30 ve deformite şiddeti Mielke ve Stevens’in tanımına göre Zon III idi. Mekanik medial proksimal açı (MPTA) ve mekanik aks kayması (MAD) ameliyat öncesi, ameliyat sonrası ve son kontrolde ölçüldü. Ameliyatın sonucu, plak çıkarma aşamasındaki veya iskelet matüritesindeki tibia varanın düzelme derecesi ölçülerek değerlendirildi.

Bulgular: Cerrahi esnasında hastaların yaş ve VKİ değerleri ortalaması sırasıyla, 13 yıl (dağılım 12-14 yıl) ve 33.5 kg/m² (dağılım 31-36) idi. Hastalar ortalama 22 ay (dağılım 13-31) takip edildi. Ameliyat öncesi ve son kontroldeki MPTA değerlerinin ortalaması sırasıyla 81 ve 80 derece olarak bulundu. Ameliyat edilen iki ekstremitede tibia vara açısının arttığı (ortalama 6.5 derece), iki ekstremitede deformitede hiç düzelme olmadığı ve kalan iki ekstremitede minimal düzelme olduğu (ortalama 3 derece) gözlemlendi. Tibia vara deformitesini düzeltmek amaçlı yapılan bu cerrahi işlem tüm ekstremitelerde başarısız oldu ve tüm hastalara osteotomi yapılması planlandı.

Sonuç: Obez adolesan Blount hastalarının tedavisinde bir gergi bandı plağı olan sekiz plağı (orthofix) ile hemiepipifizez yapılmasını önermiyoruz.

Anahtar sözcükler: Adolesan; Blount; hemiepipifizez; sekiz-plağı; obezite.

Adolescent Blount disease is a varus deformity caused by inhibition of growth in the medial aspect of the proximal tibial physis in adolescent children.^[1] This is thought to be result of suppression of growth secondary to increased forces across the physis from obesity.^[2,3]

Tibial osteotomy, bony hemi-epiphysiodesis, staples, and tension band plate (Orthofix eight-Plate) hemi-epiphyseodesis have been reported as methods of successful treatment. Proximal tibial osteotomy is a frequently employed technique but may have profound complications such as postoperative alignment problems (undercorrection or overcorrection), union problems (malunion, nonunion), nerve palsy, and compartment syndrome.^[4-6] The use of external fixators to stabilize the osteotomy has an advantage of allowing gradual correction^[7] of the deformity but is also associated with many complications like pin or tract infection, nerve palsy, joint stiffness, and muscle weakness.^[8] Hemiepiphyseal stapling is another technique first described by Blount in 1949^[9] and aimed to correct the deformity by providing a temporary hemi-epiphysiodesis.^[10] Recently, Stevens described a simple technique using an eight-Plate tension band device to achieve a temporary hemi-epiphysiodesis (Orthofix, McKinney, TX) for treating various angular deformities in children. However, the results of this treatment in obese children with adolescent tibia vara are unclear.^[11]

We aimed to evaluate the outcomes of eight-Plate (Orthofix) hemiepiphysiodesis for growth modulation of adolescent Blount disease in obese children by following growth changes in the tibia in a consecutive series of patients.

PATIENTS AND METHODS

Institutional review board approval was obtained to study a consecutive series of obese children with adolescent Blount disease treated with a lateral proximal tibial hemi-epiphysiodesis with tension band plate (Orthofix eight-Plate) in our hospital between 2006 and 2008. Inclusion criteria consisted of the following: a diagnosis of adolescent Blount disease with zone 3 deformity as described by Mielke and Stevens,^[12] age greater than 10 years at initial diagnosis, body mass index (BMI) >30, treatment with a eight-Plate lateral proximal tibial hemi-epiphysiodesis by the operative technique as described by Stevens,^[11] and follow-up to maturity or plate removal (12-31 months).

We excluded patients with residual infantile tibia vara, metabolic bone disease, achondroplasia, or skeletal dysplasia. Collected data included demographics,

surgical parameters to include complications, and radiographs. From the medical records, the following demographic data was obtained to include: age at surgery, BMI at the time of application of the plate and complications.

Surgery was performed under general anesthesia in supine position through a 2 to 3 cm incision. The lateral proximal epiphysis of tibia was reached under fluoroscopic guidance and each plate was placed in a submuscular or subfascial position, with care taken to preserve the periosteum. Typically, the plate was placed in or just posterior to the midsagittal plane so as to avoid genu recurvatum.

Radiographic measurements were obtained from standing digital scans from the superior pelvic area to the foot before the surgery, at six months postoperatively, and at the time of final follow-up (considered to maturity or date of plate removal). Radiographic measurements were obtained by the method of Paley and include mechanical medial proximal tibial angle (MPTA) and mechanical axis deviation (MAD).^[13]

RESULTS

The eight-Plate (Orthofix) was used to perform a proximal lateral tibial hemi-epiphysiodesis in six extremities of five patients (3 males, 2 females; mean age 13 years; range 12 to 14 years). The average BMI at the surgery time (BMI=patient's weight in kilograms/the square of the patient's height in meters) was 33.5 kg/m² (range, 31 to 36 kg/m²). All of our patients exceeded the 95th percentile and were considered obese according to Centers for Disease Control Growth Charts.^[14] The average duration between insertion and removal of the eight-Plate was 22.2 months (range, 13 to 31 months).

Radiographic measurements show a preoperative tibia vara to have an average MPTA of 81 degrees (range of 76 to 84), and all extremities had a zone 3 deformity. In the postoperative six month visit, we had an average MPTA of 80 degrees (range of 75 to 84). At the time of last follow-up (maturity or plate removal) average MPTA was 80 degrees (range of 74 to 83). Two knees showed some correction of the tibia vara, two knees showed progression of the tibia vara and two knees did not show any change (Table 1). At the end of the follow-up period, patients had still zone 3 deformity.

We did not observe any complications in the perioperative or postoperative period such as infections or hardware failures.

DISCUSSION

Adolescent Blount disease is a varus deformity of the tibia caused by inhibition of growth in the

TABLE I
Patients' demographics and deformities

Patient no	Age, (years)	BMI, (kg/m ²)	Follow-up, (months)	MPTA (degree)		MAD (mm)	
				Preoperative	Postoperative	Preoperative	Postoperative
1	14.08	34.5	31	76(L)	81(L)	40.1(L)	26.4(L)
2	12.80	33	13	83(L)	82(L)	75.0(L)	63.2(L)
3	13.00	36	22	81(R)	83(R)	59.5(L)	60.1(L)
4	12.80	31	27	80(R)	74(R)	90.4(R)	113.3(R)
				83(L)	79(L)	79.0(L)	114.2(L)
5	12.40	33	25	80(L)	82(L)	67.3(L)	56.7(L)

BMI: Body Mass Index; MPTA: Mechanical proximal tibial angle; MAD: Mechanical axis deviation.

medial aspect of the proximal tibial physis in obese adolescent children.^[1,3] Obese children may have a mechanical basis for adolescent Blount disease and growth inhibition may occur from excessive compressive forces, as suggested by the Heuter-Volkman principle.^[15] Correction of the deformity is desired because untreated Blount disease results in gait problems and premature osteoarthritis of the knee in young adults.^[16]

Acute or gradual correction of the varus deformity has been achieved frequently through a proximal osteotomy of the tibia with several types of procedures and fixation methods.^[17-23] Regardless of the type of surgery and the fixation method, acute correction has potential complications like neurologic injury and compartment syndrome.^[24] Gradual correction with external fixation seems more reliable and safer; however, it has some disadvantages like poor patient compliance, infection of pins, and slow healing with prolonged fixator requirement.^[8,17,18] Since osteotomies have many problems, a simpler technique that utilizes correction by guided growth of the proximal tibial physis appears encouraging.

Hemi-epiphysiodesis to treat Blount disease is an operation in which the physis is tethered laterally and remaining unrestricted medial physeal growth corrects angular deformities in children. Hemi-epiphysiodesis can be accomplished by procedures such as partial physeal ablation (lateral bony hemi-epiphyseodesis), transphyseal screw placement, staples, and eight-Plate tension band device (Orthofix).^[25,26] The partial physeal ablation method has disadvantages of being permanent and requiring exact timing for surgery. Staples, transphyseal screws, and tension band plates (eight-Plate) have the theoretical advantage of being reversible. Transphyseal screws have the risk of growth disturbance because of crossing physis and staples have some potential complications such as breakage, migration, and difficulty of removal.^[27] Guided growth

with eight-Plate (Orthofix) is a recently popularized method with a temporary extraperiosteal placement and easy removal without physeal damage.^[11]

Outcomes for correction by hemi-epiphysiodesis in adolescent Blount disease have confusing results. Castañeda et al.^[26] reported an improvement of only 1.2 degrees at MPTA with staple hemi-epiphyseodesis in 21 patients with infantile, juvenile, and adolescent



Figure 1. (a) Preoperative X-ray of patient 5. (b) Postoperative 18 months X-ray of patient 5.

Blount disease; however, there is a lack of data concerning the number of adolescent patients and their obesity. Park et al.^[10] classified the severity of the deformity in their study population according to Mielke and Stevens's method^[12] and reported their outcomes with staples in late-onset tibia vara. The authors recommended hemiepiphysial stapling in children younger than 10 years of age with mild or moderate varus deformity. Westberry et al.^[28] treated 23 patients with lateral staple hemiepiphysiodesis for Blount disease and nine of them required corrective osteotomy. Recently, McIntosh et al.^[29] reported their results with staple hemiepiphysiodeses in 49 patients with late-onset Blount disease. They had residual mechanic axis deviation in 66% of these patients after a 3.3 years follow-up and thought that obesity (BMI >40) and degree of deformity (MPTA <76 degrees) were the responsible factors in this outcome.

There are very few studies about adolescent Blount disease treated by tension band plate hemiepiphysiodesis.^[11,30] Stevens^[11] described the tension band plate technique with his preliminary report in 2007 and since then, this technique has been widely used to treat angular deformities of knee in children. In his report, Stevens presented five patients with adolescent Blount disease of which two of the patients did not receive correction. We treated obese (BMI >30) adolescent Blount patients with eight-Plate (Orthofix) hemiepiphysiodesis and were very disappointed that no patient benefited from this surgery. We thought that eight-Plate (Orthofix) hemiepiphysiodesis would correct the deformity and that correction may follow the predictive chart as described by Bowen et al.^[25] however no success was achieved. Our average value for MPTA showed minimal change from preoperative values to the final values and some patients even got worse. Schroerlucke et al.^[30] reported 18 patients with adolescent Blount disease using tension band plate (Orthofix, eight-Plate) technique and observed implant failures in eight of them. He concluded that a BMI >31 was associated with hardware failure since several plate-screws broke. In our study, there were no mechanical failures and no complications related to the operative procedure. We believe that the combination of obesity and advanced varus deformity caused excessive forces across the medial area of the tibial physis, which inhibited growth and led to the failure of correction in our patients.

A weakness of our paper is having small numbers of operative procedures; however, with no effective correction of the deformity in any extremity, our excitement for continuing to perform this procedure has waned.

In conclusion, this paper reports the failure of proximal tibial deformity correction of adolescent Blount disease with severe (zone 3) varus deformity by a tension band plate hemi-epiphysiodesis technique (Orthofix eight-Plate) in obese children. All of our patients showed failure of correction and in two extremities the varus deformity progressed at the proximal tibia while the eight-Plate for hemiepiphysiodeses was in place. We do not recommend the use of an eight-Plate (Orthofix) hemiepiphysiodesis to treat severe adolescent Blount disease in obese children.

Declaration of conflicting interests

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