Hemiepiphyseal stapling for treatment of genu valgum: A case report

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Abstract

A 12-year-old girl underwent a bilateral distal femoral and proximal tibial medial hemi-epiphyseal stapling for correction of genu valgum deformity of both knees. The preoperative inter-malleolar distance in stance measured 15 cm. By the five month follow-up visit there was complete correction of the genu valgum deformity. At age 13 years, the patient underwent staple removal and complete percutaneous epiphysiodesis for the resolved genu valgum deformity of both knees. At the five year follow-up visit the patient maintained complete correction of the angular deformity without recurrence.

Background

Since the introduction of wire staples by Walter Blount in 1949, hemiepiphyseal stapling has become a common method of correcting angular deformities of the knee in children. While the practice of hemiepiphyseal stapling is no longer novel, its outcome in the long term remains a topic of debate. Long-term follow-up, therefore, is crucial in demonstrating that significant under-correction or over-correction has not occurred, the implanted hardware has not failed, and that additional corrective surgery is not required. Recently, the tension band technique, whereby a non locking extraperiosteal plate and two screws are implanted to restrain the physis, has been presented as a preferable alternative to stapling.[1] This case report presents findings, consistent with current literature, to illustrate that hemiepiphyseal stapling is an effective means to treat adolescent genu valgum.

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Case Report

A 12-year-old, pre-menarchal female was referred to our tertiary-level center for increasing valgus deformity of the knees (Figure 1). At the time of her first office visit, her height was 158.4 cm and her weight was 47.3 kg. Past medical history included a facial hemangioma and obstructed airway, for which she was given high doses of Prednisone early in life. The steroids retarded her growth for a

Figure 1: Pre-operative photo

significant period of time. There was no history of injury or infection to her knees.

The initial physical examination showed an inter-malleolar distance in stance of 12 cm; at the time of surgery it measured 15 cm (Figure 2). Both

Figure 2: Pre-operative AP radiograph

ankles were in valgus. Knees moved from negative 5 degrees of extension to 140 degrees of flexion. Cruciate and collateral ligament testing was normal. The joints were non-tender. Hip motion was within normal limits. Motor and sensation were intact. Leg lengths were equivalent. X-rays revealed approximately a 15 degree valgus position of both knees, the majority of angulation appeared to be from the tibia. Her bone age was 1-2 standard deviations below her expected bone age. Anteroposterior and lateral radiographs were examined to assess the mechanical and femoral tibial angles while standing to assess the deformity. Her distal femoral and proximal tibial growth plates were both still open. Given the degree of valgus deformity and the fact that the deformity was not localized to the tibia alone, it was felt that combined distal femoral and tibial hemiepiphysiodesis would offer the best and most comprehensive correction. A bilateral medial hemiepiphyseal stapling procedure was performed in November, 2002 and consisted of the insertion of three 5/8 inch vitallium staples (Zimmer, Inc., Warsaw, IN) which bridged the medial distal femoral physes and medial proximal tibial physes (Figure 3).

Figure 3: Intra-operative images

Eight days after the operation the patient had minimal pain and discomfort. Post operative radiographs showed hardware in good position. The inter-malleolar distance in stance had improved to 8.5 cm by two and a half months after surgery and to 4 cm by four months (Figure 4). At six months follow up, her correction was satisfactory and her mechanical axis and genu valgum both measured 0 degrees. X-rays showed that her growth plates were still open. The patient's bone age was not repeated.

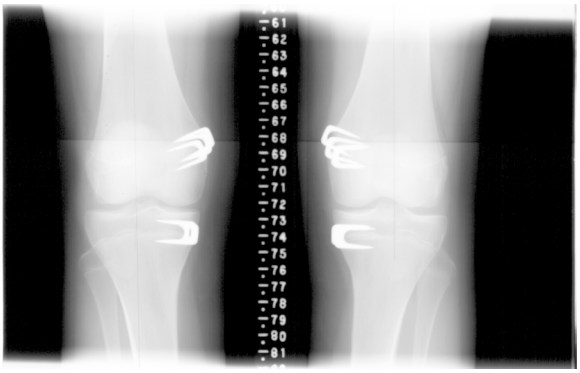

Figure 4: Five months post-operative AP radiograph

Given satisfactory correction of her deformity with distal femoral and proximal tibial hemiepiphysiodesis and the suggestion of residual opening of the lateral hemiephysis and preoperative bone age 1-2 standard deviations below expected, we felt that the potential rebound effect of staple removal alone would threaten the correction achieved without further growth modulation. Therefore we advised complete epiphysiodesis. The pros and cons of staple removal alone, which include possible rebound effect and recurrence of deformity, versus staple removal and complete percutaneous epiphysiodesis were discussed with the patient and her family. The patient chose staple removal and complete epiphysiodesis of both distal femurs and proximal tibias. Following this treatment the patient continued to use her T-ROM braces while the bone reconstituted itself.

The patient's follow-up physical exams and x-rays over the past five years have indicated satisfactory position and alignment of both knees, with complete correction of her valgus deformity (Figure 5). Given that her growth plates have closed and that she is skeletally mature, we do not anticipate any further rebound effect or residual deformity.

Figure 5: Five years post-operative

Discussion

Genu valgum is a deformity of the knee commonly affecting children and adolescents. Its true incidence is unknown.[2] Physiological genu valgum, occurring as a result of the natural development of the tibiofemoral angle, is most common and usually corrects spontaneously by the age of seven or eight years. Pathological genu valgum, which is defined by a tibiofemoral angle that is more than two standard deviations above the mean, is less common and is likely to progress over time and to require treatment.[3, 4] Idiopathic genu valgum occurs when physiological forms of genu valgus do not resolve. This leads to continued and/or progressive knee deformity. Excess genu valgum is characterized by a gait pattern of circumduction, joint instability, and anterior and medial knee pain. Hypoplasia of the lateral femoral condyle can develop; the hip and ankle may be involved secondarily.[2, 3, 5] As gait mechanics are progressively disturbed, multiple physes become subject to pathological bending, shear, and torsional forces.[1] Orthopaedic intervention is essential as the patient is unable to run, ride a bicycle, or participate safely and effectively in sports activities; furthermore, if the valgus deformity is left untreated, total knee arthroplasty may become necessary in adulthood.

Non-operative treatment options for genu valgum include observation in case of spontaneous correction, physical therapy, bracing, non-steroidal anti-inflammatory drugs, and/or lifestyle restrictions.[2, 6] The efficacy of these treatment modalities remain unknown. If a tibiofemoral angle of more than 15 degrees or an inter-malleolar distance of 10 cm persists after age 10, it is likely that spontaneous correction will not occur and operative treatment will be necessary.[3, 7]

Options for operative treatment include corrective osteotomy, partial epiphysiodesis, and hemiepiphyseal stapling.[1, 3, 4, 6] Osteotomy of the femur and/or tibia and fibula is the classic and accepted method of correcting pathologic angular deformities of the knee; however, the morbidity associated with this procedure is frequent and severe.[8-10] Complications include malunion, failure of fixation, and loss of correction.[11] Partial epiphysiodesis is the simplest procedure and can be performed through a standard incision or percutaneously; the disadvantages are that the procedure is irreversible, and successful correction is predicated upon precise timing and accurate prediction of remaining growth and its effect on angular deformity.[1, 3] Estimation of skeletal maturity is generally considered an approximation; therefore, permanent epiphysiodesis poses the risk of under- or over-correction.[5]

Hemiepiphyseal stapling is an ideal option because it is minimally invasive, does not ablate the growth plate as in permanent epiphysiodesis, and is theoretically reversible in the possible event of overcorrection. Recently, some physicians have advocated for guided growth using a non locking extraperiosteal 2-hole plate- commonly known as an 8-plate- and screws.[1, 12] This technique operates on the tension band principle rather than on the principle of physeal compression. The primary advantage of this procedure seems to be that the observed rate of correction is approximately 30% more rapid than the

rate of correction in stapling.[1, 12] However, the 8-plate implant is far more costly than the staple; the cost of one 8-plate and two screws is $530, whereas the cost of a single staple is $102. We use 3 staples for each physis, so the cost is $306 per physis stapled, which still represents a 42% savings. The cost-effectiveness of stapling may be worth considering, especially in the context of developing countries, where the 8-plate may be prohibitively expensive to use.

Stapling was first introduced by Walter Blount in 1949 and has since been validated by numerous studies as a safe and effective procedure with few and minor complications; it has been shown to successfully correct both mechanical axis alignment and associated gait abnormalities.[3, 5, 7, 13-16] The optimal age at which to perform surgery is controversial, although skeletal maturity is an absolute contraindication for stapling. Most studies have concluded that it is inadvisable to perform stapling sooner than the chronologic age of 10 or 11 for the following reasons: higher risk of staple migration, greater likelihood of deformity recurrence, and risk of physeal bar formation during the implantation or removal of staples.[1, 7, 9, 17] However, Mielke and Stevens showed in a preliminary report of 25 patients that hemiepiphyseal stapling can be performed successfully in children under the age of 10, while Park, et al also found that the surgery was particularly effective in patients ten years old or younger.[9, 10] The patient in this case was 12 years old and both her distal femoral and proximal tibial growth plates were still open, which made her an ideal candidate for stapling.

Most studies have found that angular deformity takes between one and two years to correct after surgery, but correction in fewer than 12 months may occur.[7, 9, 18] Our patient's valgus deformity corrected rather quickly, even drifting clinically into a few degrees of varus by five months after surgery. As some rebound growth can be expected in young patients after staple removal, it has been advised to allow for about 5 degrees of rebound, taking care to avoid overcorrection in older patients.[7, 9, 15] Given the patient's age, skeletal maturity, and degree of overcorrection, her staples were removed six months after the initial stapling surgery.

The patient's immediate and long-term follow-up show a recovery consistent with other studies: a few degrees of initial overcorrection into varus and then a gradual return to normal mechanical alignment with full knee extension and range of motion. While her outcome has clearly been successful, she has recently complained of some anterior knee pain, which we expect to resolve with strengthening and conditioning exercises for her lower extremities.

Hemiepiphyseal stapling is an effective method by which to correct angular deformities of the knee. The procedure leads to few complications, produces a desirable outcome- correction of the mechanical axis and resolution of gait circumduction- within a short period of time, and achieves long-lasting results.

References

1. Stevens PM. Guided growth for angular correction: a preliminary series using a tension band plate. J Pediatr Orthop. Apr-May 2007;27(3):253-259.
2. Stevens P, Holstrom M. Genu Valgum, Pediatrics. Web Page] Overview of genu valgum deformity and treatment options. Available at: http://www.emedicine.com/orthoped/TOPIC495.HTM. Accessed March 21, 2008.
3. White GR, Mencio GA. Genu Valgum in Children: Diagnostic and Therapeutic Alternatives. J Am Acad Orthop Surg. Oct 1995;3(5):275-283.
4. Salenius P, Vankka E. The development of the tibiofemoral angle in children. J Bone Joint Surg Am. 1975 Mar;57(2):259-61.
5. Stevens PM, MacWilliams B, Mohr RA. Gait analysis of stapling for genu valgum. J Pediatr Orthop. Jan-Feb 2004;24(1):70-74.
6. McCarthy JJ, Kim DH, Eilert RE. Posttraumatic genu valgum: operative versus nonoperative treatment. J Pediatr Orthop. Jul-Aug 1998;18(4):518-521.
7. Zuege RC, Kempken TG, Blount WP. Epiphyseal stapling for angular deformity at the knee. J Bone Joint Surg Am. Apr 1979;61(3):320-329.
8. Gordon JE, Heidenreich FP, Carpenter CJ, Kelly-Hahn J, Schoenecker PL. Comprehensive treatment of late-onset tibia vara. J Bone Joint Surg Am. Jul 2005;87(7):1561-1570.
9. Mielke CH, Stevens PM. Hemiepiphyseal stapling for knee deformities in children younger than 10 years: a preliminary report. J Pediatr Orthop. Jul-Aug 1996;16(4):423-429.
10. Park SS, Gordon JE, Luhmann SJ, Dobbs MB, Schoenecker PL. Outcome of hemiepiphyseal stapling for late-onset tibia vara. J Bone Joint Surg Am. Oct 2005;87(10):2259-2266.
11. Edgerton BC, Mariani EM, Morrey BF. Distal femoral varus osteotomy for painful genu valgum. A five-to-11-year follow-up study. Clin Orthop Relat Res. Mar 1993(288):263-269.
12. Stevens PM. Guided growth: 1933 to the present. Strategies in Trauma and Limb Reconstruction. December, 2006 2006;1(1):29-35.

13. Blount WP, Clarke GR. Control of bone growth by epiphyseal stapling; a preliminary report. J Bone Joint Surg Am. Jul 1949;31A(3):464-478.
14. Brockway A, Craig WA, Cockreli BR, Jr. End-result study of sixty-two stapling operations. J Bone Joint Surg Am. Oct 1954;36-A(5):1063-1070.
15. Fraser RK, Dickens DR, Cole WG. Medial physeal stapling for primary and secondary genu valgum in late childhood and adolescence. J Bone Joint Surg Br. Sep 1995;77(5):733-735.
16. Stevens PM, Maguire M, Dales MD, Robins AJ. Physeal stapling for idiopathic genu valgum. J Pediatr Orthop. Sep-Oct 1999;19(5):645-649.
17. Raab P, Wild A, Seller K, Krauspe R. Correction of length discrepancies and angular deformities of the leg by Blount's epiphyseal stapling. Eur J Pediatr. Nov 2001;160(11):668-674.
18. Pistevos G, Duckworth T. The correction of genu valgum by epiphysial stapling. J Bone Joint Surg Br. Feb 1977;59(1):72-76.