# Temporary epiphysiodesis with Blount stapling for treatment of idiopathic genua valga in children

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**Not all idiopathic genua valga in children show an innocuous evolution. If the deformity persists or increases, it can cause a long-term cosmetic or functional problem. The problem can easily be corrected, with only limited risks for complications, with temporary medial hemi-epiphysiodesis of the growth plates around the knees. This retrospective study considers the pre- and postoperative evolution of 44 patients who underwent temporary stapling of the medial femoral and tibial physes following Blount's technique. Ninety percent were satisfied and showed good correction of the knee alignment. Four patients were not satisfied with the result, owing to recurrence of the valgus deformity ; two of them had a good result after revision surgery. The condition was assessed by measuring clinically the intermalleolar distance and the radiological hip-knee-ankle angle. Average age at the time of surgery was 12 years six months for girls and 13 years eight months for boys. Pre-operative evaluation of skeletal age on radiographs of the hand is advised. There is a rebound phenomenon after hardware removal, with an average recurrence of the valgus deformity of 4°. Blount stapling appears as a reliable method for treatment of idiopathic genua valga in children, with satisfactory results and few complications.**

## INTRODUCTION

Deviations of the axis of the knees in the frontal plane are very frequent in children ; most of them correct spontaneously. There is a well-known evolution from genua vara in the toddler under three years old, towards genua valga in the young child with normalisation of the knee axis around the age of six (12, 13, 15). Afterwards girls show a constant valgus evolution and boys show a varus evolution in the last two years of growth (19, 23). If however a genua valga configuration persists in adolescence or if it appears at a later age as in true adolescent genua valga, this can cause long- term problems. A number of patients will have cosmetic complaints. Chronic overuse of the lateral knee compartment carries with it a high risk of subsequent degenerative arthritis of the knee. Eighty percent of the persisting genua valga are idiopathic (4, 7, 28). One has to make a difference between other causes as there are also posttraumatic, septic and syndrome-related genua valga (27). Surgery for axis correction can be performed at a later age using high tibial osteotomy. This is more demanding surgery with a significant complication rate and an important rehabilitation period (21). Temporary medial epiphysiodesis of the distal femur and/or proximal tibia was introduced to avoid this in a simple manner.

Temporary epiphysiodesis is based on Blount's technique. He reported on control of bone growth

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by epiphyseal stapling in 1949 (2, 3, 11, 16, 18, 20). At the beginning, the technique was used to correct leg length discrepancies. The value of hemi-epiphysiodesis for correction of axis deviations then became progressively evident. Surgery is best performed in late adolescence to avoid the risk of recurrent genua valga from additional growth (14). On the other hand at least one year of remaining growth capacity is necessary to achieve satisfactory correction (1).

This is a retrospective study of 44 patients with idiopathic genua valga who were treated by temporary hemi-epiphysiodesis, and were followed until skeletal maturity.

## MATERIAL AND METHODS

The medical records of the 44 patients (88 knees) showing adolescent idiopathic genua valga, who were treated surgically by temporary medial hemi-epiphysiodesis with staples at the University Hospital Pellenberg during the period 1985 to 1997 were reviewed. There were 26 boys and 18 girls. All the patients were followed clinically and radiologically until they reached skeletal maturity. Obesity was obvious in 25 of the 44 patients.

Clinical assessment took into consideration the patients' complaints and satisfaction, scars, complications, obesity and intermalleolar distances (IMD) (fig 1a).

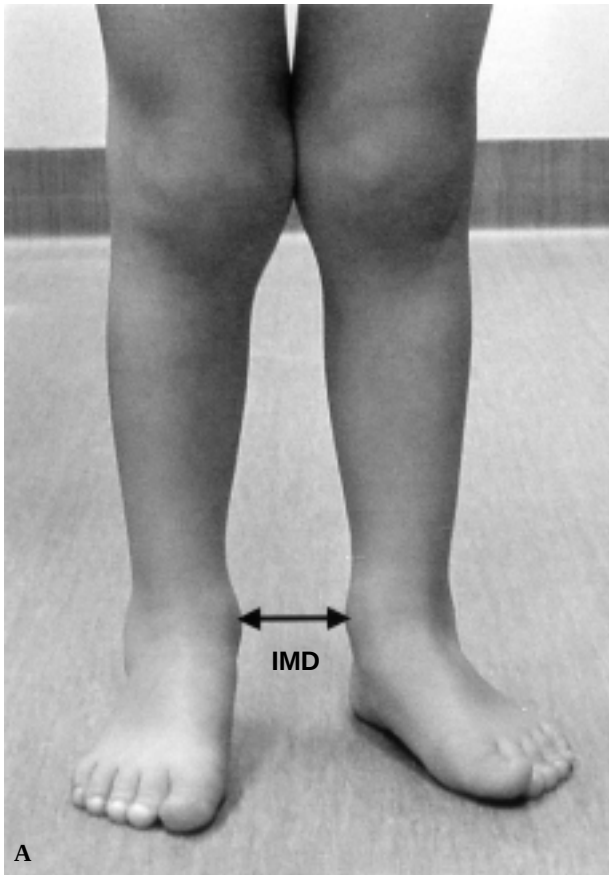
Radiologic assessment was done by measuring the Hip-Knee-Ankle angle (HKA) between femur and tibia. The mechanical axis of the femur passes from the center of the femoral head to the center of the knee. The mechanical axis of the tibia passes from the center of the tibial spine to the center of the ankle mortise. The angle between these two axes is known as the Hip-Knee-Ankle (HKA) angle. The HKA angle is expressed as degrees of deviation from linearity (neutral alignment : the femoral and tibial mechanical axis are in line with each other, the HKA angle is 0°). In varus deformity the axis is angled laterally and in valgus medially (fig 1b). A standard frontal full-leg radiograph was used (fig 2). The measurements were done immediately before surgery, at the time of removal of the staples and after reaching skeletal maturity, with the patient always standing upright, patellae pointing forward and the knees in contact with each other. Measurements were noted at the time of stapling, at the time of removal of the staples and after reaching skeletal maturity. Genua valga were defined as having an HKA angle under –3° and genua vara over 3°. Values between -3° and +3° were considered as normal. Age at surgery and the time interval between stapling and removal of the staples was recorded.

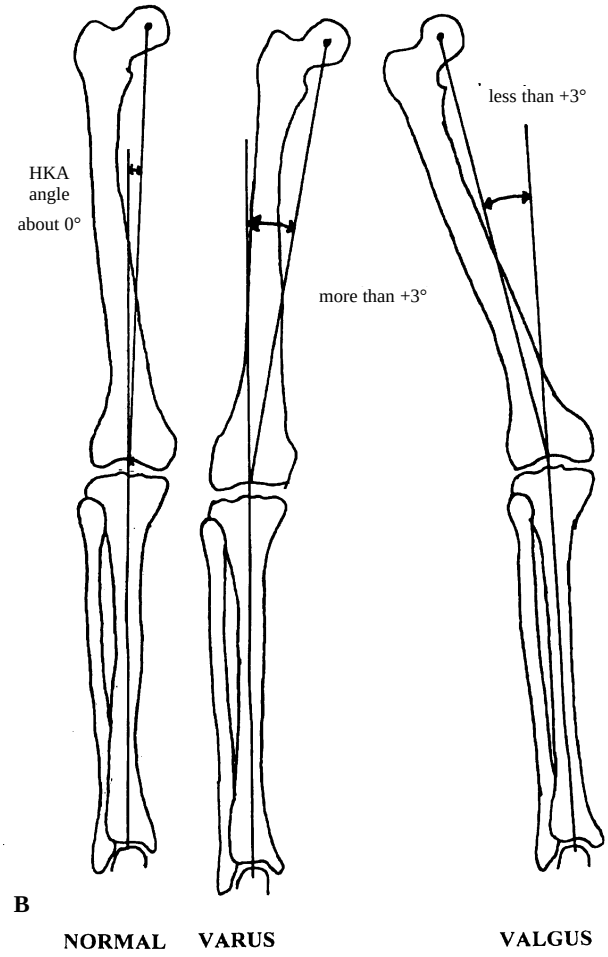
Blount's technique was used, placing three staples distally on the medial femoral epiphysis and three staples on the medial proximal tibial epiphysis, except in one patient who only underwent tibial stapling. Fluoroscopy was used during surgery.

## RESULTS

The average age at the time of stapling was 13 years (y) and 2 months (m) (ranging from 11 y 5 m to 16 y) : 13 y 8 m (11 y 6 m to 16 y) in boys and 12 y 6 m (11 y 5 m to 13 y 9 m) in girls. The average period between epiphysiodesis and staple removal was 7 m (3 m to 18 m). The IMD showed an average decrease from 11 cm (8 to 17 cm) to 2 cm (0 to 15 cm) after reaching skeletal maturity. The HKA angle assessed on radiographs showed an average correction from –5° (-12° to 2°) at the time of stapling to 4° (-4° to 10°) at the time of removal of the staples, ending at 0° (-11° to 12°) after reaching skeletal maturity. The rebound effect was thus on average 4° (0° to 21°).

Forty patients were satisfied with the results. Four unsatisfied patients showed recurrent genua valga. Two were re-operated using the same technique. They eventually showed a good result (0°/2° and –4°/-2° MA at skeletal maturity). One patient with recurrent genua valga refused secondary surgery. The fourth patient had already reached bony maturity, making revision stapling impossible and the situation was accepted as such. Six patients had a slight recurvatum of 10° to 20° after correction of the valgus. All of these patients, however, were satisfied with the final result. Two patients showed a temporary loss of sensitivity in the territory of the infrapatellar nerve, with quick recovery. One patient showed a measurable leg length discrepancy of 1 cm, without any complaints. Two patients needed a manipulation under general anaesthesia after the stapling procedure owing to slow recovery of ROM. Both regained normal mobility. Four patients showed a slight persisting overcorrection with varus angulation, but all of them were satisfied. One patient had a superficial *staphylococcus*



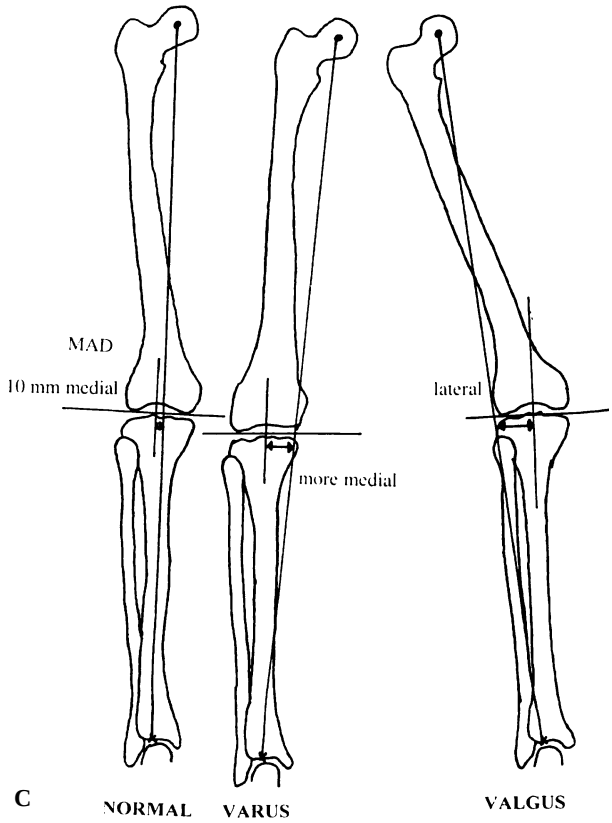




Fig. 1. — A) IMD= intermalleolar distance (0 cm is considered normal) ; B) HKA angle (HKA) (between -3° and +3° is considered normal) ; C) mechanical axis of the limb (projection on a full-leg AP radiograph taken under weight-bearing conditions).

*aureus* infection of the wound, but healed rapidly with local wound care and antibiotic therapy.

Only nine patients had a cosmetically acceptable scar. Thirty one patients had a broad and flat scar. Four patients had keloid scar formation (table I).

## DISCUSSION

Temporary stapling of an epiphysis causes temporary growth arrest (8, 26). After staple removal, growth resumes. This is a well-studied phenomenon. Reversibility after temporary stapling makes timing of this technique easier, compared to irreversible percutaneous epiphysiodesis (30). The results of this study prove the technique of temporary medial hemi-epiphysiodesis of distal femur and proximal tibia following Blount's technique to be

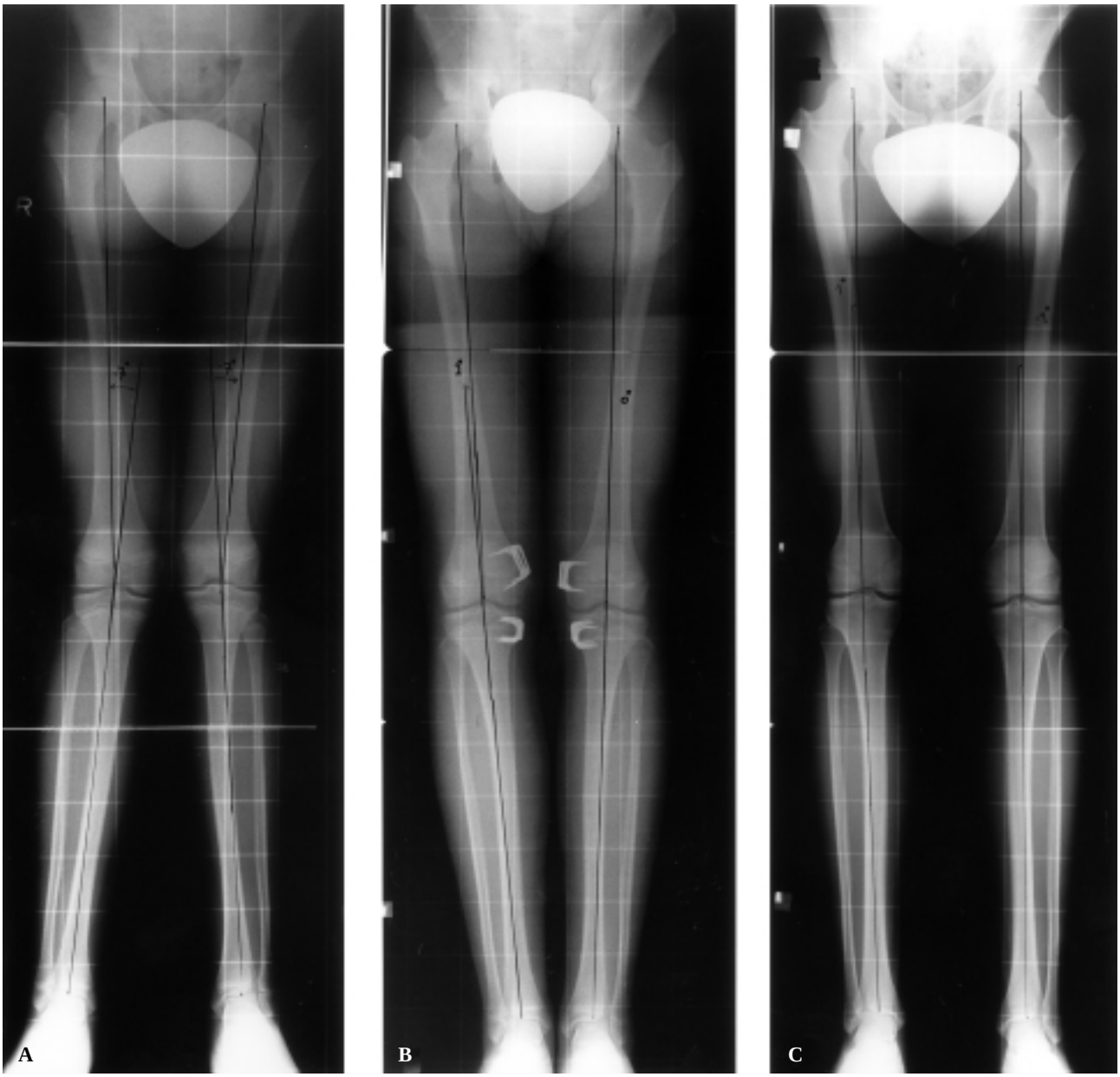



Fig. 2. — A) radiograph showing frontal full-leg images at the time of surgery ; B) after correction achieved by stapling ; C) at bony maturity and after removal of the staples.

an effective way to reach correction of idiopathic genua valga in adolescents (18). The surgery itself is not very invasive and is obviously much easier to tolerate for the patient than an osteotomy. Stapling also shows few complications. A problem however remains the broad and flat scar (17). Good timing is necessary to achieve the result desired and to avoid recurrent genua valga. Different methods to estimate the optimal timing are used. Using Green and Anderson's predictive tables for angular deformity which take into account the residual growth, has been shown to be much more reliable than empirical determination of the age for surgery, to reach a predictable result (5). Determination of skeletal age

Table I. — Overview of the results in individual patients. (B = boy, G = girl ; y = year, m = month ; IMD = intermalleolar distance ; HKA = Hip-Knee-Ankle angle (right/left) ; rem = removal staples ; OS = stapling ; satisfact = satisfaction ; MSSA = methicilline sensible staphylococcus aureus ; BLD = bone length discrepancy, n.infrapat = nervus infrapatellaris ; mat = bony maturity ; MUGA = manipulation under general anaesthesia ; post = at skeletal maturity)

| | | *Age* | | *IMD(cm)* | | | *HKA(degrees)* | | | *Satis-fact* | *Obe-sity* | *Scar* | *Complications* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | stapling | time | pre | rem | post | pre | rem | post | | | | |
| 1 | B | 12 y 4 m | 6 | 9 | 0 | 0 | -12/-12 | 10/9 | 1/3 | + | – | Nice | None |
| 2 | G | 12 y 1 m | 8 | 10 | 1 | 0 | -5/-9 | 5/2 | 1/2 | + | – | Nice | None |
| 3 | G | 12 y 1 m | 7 | 12 | 0 | 1 | 2/-1 | 10/8 | 0/-1 | + | + | Keloid | None |
| 4 | G | 12 y 3 m | 11 | 10 | 0 | 2 | -5/-6 | 4/4 | 3/3 | + | – | Broad | MUGA after OS |
| 5 | G | 12 y 1 m | 7 | 13 | 0 | 0 | -6/-4 | 0/0 | -2/-3 | + | + | Keloid | None |
| 6 | B | 15 y 8 m | 9 | 9 | 0 | 0 | -5/-5 | 5/4 | 2/2 | + | + | Broad | None |
| 7 | B | 13 y 2 m | 7 | 14 | 0 | 10 | -6/-7 | 6/3 | -5/-6 | – | – | Broad | Recurrency, revision |
| 8 | B | 12 y 2 m | 5 | 14 | 0 | 1 | -7/-5 | 4/5 | -4/-3 | + | – | Broad | None |
| 9 | B | 15 y 0 m | 7 | 17 | 0 | 0 | -5/-10 | 3/3 | 0/-2 | + | + | Broad | Only tibial stapling |
| 10 | G | 11 y 11 m | 12 | 8 | 2 | 2 | -2/-1 | 3/3 | -1/-1 | + | + | Keloid | None |
| 11 | B | 14 y 0 m | 6 | 10 | 0 | 0 | -6/-5 | 4/8 | -2/-1 | + | – | Broad | n.infrapat (recovery) |
| 12 | G | 13 y 6 m | 10 | 16 | 0 | 6 | -3/-10 | 7/-2 | 3/-3 | + | – | Broad | Idem, recurvatum 20° |
| 13 | B | 13 y 9 m | 8 | 13 | 0 | 1 | -8/-7 | 4/8 | -2/0 | + | – | Nice | None |
| 14 | G | 12 y 3 m | 11 | 10 | 0 | 1 | -6/-7 | 0/-1 | -1/1 | + | + | Broad | BLD 1 cm |
| 15 | B | 12 y 11 m | 3 | 8 | 0 | 0 | -7/-7 | 2/0 | -1/1 | + | – | Broad | None |
| 16 | G | 12 y 3 m | 14 | 15 | 0 | 0 | -7/-7 | 2/6 | 1/2 | + | + | Broad | None |
| 17 | G | 12 y 8 m | 6 | 8 | 0 | 0 | -3/-3 | 7/6 | 4/3 | + | + | Broad | Recurvatum 15°, varus |
| 18 | G | 12 y 0 m | 5 | 11 | 0 | 7 | -4/-1 | 6/4 | -2/1 | – | + | Broad | Recurrency, revision |
| 19 | G | 12 y 9 m | 7 | 9 | 0 | 1 | -5/-4 | 5/5 | -1/-2 | + | – | Broad | None |
| 20 | G | 13 y 5 m | 13 | 14 | 0 | 0 | -4/-3 | 2/4 | 0/2 | + | – | Nice | None |
| 21 | B | 16 y 0 m | 5 | 10 | 0 | 0 | -6/-6 | 2/1 | 0/-2 | + | – | Broad | Recurvatum 15° |
| 22 | B | 13 y 0 m | 6 | 12 | 0 | 3 | -5/-7 | 6/4 | -3/-1 | + | – | Broad | Infection MSSA |
| 23 | G | 12 y 4 m | 6 | 8 | 0 | 3 | -5/-4 | 6/4 | -2/-3 | + | + | Broad | None |
| 24 | B | 13 y 2 m | 4 | 10 | 0 | 1 | -9/-9 | 1/5 | 0/-1 | + | – | Broad | None |
| 25 | B | 13 y 0 m | 6 | 10 | 0 | 0 | -5/-5 | 9/8 | 0/0 | + | – | Broad | None |
| 26 | B | 13 y 8 m | 6 | 12 | 0 | 0 | -3/-5 | 4/2 | 5/5 | + | + | Broad | None |
| 27 | G | 12 y 8 m | 7 | 13 | 0 | 1 | -10/-10 | 4/5 | -2/-1 | + | – | Broad | Recurvatum 15° |
| 28 | B | 13 y 6 m | 5 | 10 | 0 | 0 | 0/-3 | 6/6 | 12/8 | + | + | Broad | Varus left |
| 29 | B | 14 y 4 m | 6 | 17 | 0 | 0 | -5/-2 | -2/-4 | -2/-2 | + | + | Nice | Recurvatum 10° |
| 30 | G | 11 y 5 m | 5 | 12 | 0 | 0 | -2/-3 | 2/3 | -1/0 | + | – | Broad | None |
| 31 | B | 14 y 4 m | 5 | 11 | 0 | 0 | -4/-4 | -1/-3 | -1/-2 | + | + | Nice | None |
| 32 | B | 13 y 8 m | 4 | 8 | 0 | 3 | -5/-5 | 4/4 | -3/0 | + | + | Nice | Slight valgus |
| 33 | G | 13 y 3 m | 5 | 10 | 0 | 0 | -6/-5 | 4/0 | 2/0 | + | – | Broad | None |
| 34 | G | 12 y 7 m | 18 | 11 | 0 | 0 | -5/-3 | 2/1 | 2/0 | + | – | Broad | None |
| 35 | B | 12 y 10 m | 3 | 10 | 0 | 5 | -5/-5 | 4/4 | -3/-3 | + | – | Breed | None |
| 36 | B | 11 y 6 m | 4 | 15 | 0 | 15 | -4/-5 | 9/10 | -10/-11 | – | + | Keloid | Recurrence (no surgery) |
| 37 | B | 14 y 2 m | 7 | 10 | 0 | 0 | -5/-5 | 5/5 | 1/2 | + | – | Nice | None |
| 38 | B | 13 y 1 m | 9 | 15 | 0 | 2 | -5/-4 | 5/9 | -2/3 | + | + | Nice | None |
| 39 | B | 14 y 8 m | 5 | 8 | 0 | 0 | -5/-4 | 3/5 | -1/0 | + | – | Broad | None |
| 40 | B | 14 y 2 m | 17 | 8 | 0 | 5 | -5/2 | 7/8 | -5/-4 | + | – | Broad | MUGA aft OS, recurrence |
| 41 | G | 13 y 3 m | 4 | 8 | 2 | 0 | -4/-5 | 1/0 | 1/0 | + | – | Broad | None |
| 42 | B | 14 y 0 m | 6 | 14 | 0 | 0 | -6/-5 | 9/10 | 0/0 | + | + | Broad | None |
| 43 | B | 14 y 11 m | 9 | 12 | 0 | 0 | -5/-4 | 4/7 | 3/5 | + | + | Broad | Recurvatum 20° |
| 44 | B | 13 y 6 m | 8 | 10 | 0 | 7 | -6/-3 | 8/4 | -6/-4 | – | – | Broad | Recurrence (mat) |

using the atlas of Greulich and Pyle is currently used in our department. The average age at stapling is slightly younger for girls (12 y 6 m) than for boys (13 y 8 m), related to a later growth arrest for boys. Intensive follow-up, for example every three months with radiological measurements is absolutely necessary to avoid overcorrection (6). Some overcorrection is however necessary to accomodate for the rebound phenomenon (6, 22, 29). In our study there was a mean rebound in angular deformity of 4° following removal of the staples. A few patients found the surgical procedure painful and therefore showed temporary restriction in mobility. They needed a manipulation under general anaesthesia and showed fast and complete recovery of knee mobility afterwards, with the help of intensive physiotherapy. Sufficient pain therapy together with quick mobilisation is an important point in postoperative management. Infections are rare if correct rules of sterility are followed. The only wound infection that occurred in this study, was superficial and healed rapidly with local wound care and antibiotics.

Objective measurements on standard radiographs should be used to make a proper indication. The Hip-Knee-Ankle angle (HKA) as used in our study is a reliable method. HKA values are considered normal between –3° and +3° (4, 25). The lower limb mechanical axis deviation (MAD) is also a good assessment, but it was not measured in this study (fig 1c). Normally the mechanical axis runs slightly medial (10 mm) to the intercondylar midpoint. If this line runs laterally, this can cause chronic overuse of the lateral compartment resulting in premature degenerative arthritis with progression of the valgus axis deviation (7, 9). For radiologic assessment additional parameters should be considered : mechanical axis, mechanical axis deviation, medial proximal tibial angle and lateral distal femoral angle can be used to adjust the level of epiphysiodesis to the frontal orientation of the articulating surface of the knee (10). It is probably not always necessary to hemi-epiphysiodese femur and tibia. After adding the medial proximal tibial angle and lateral distal femoral angle to our preop. measurements, the epiphysiodesis site is selected accordingly, so as to keep the joint line horizontal. Measurement of the intermalleolar distance is an interesting clinical assessment, but is completely dependent on the contour of the thighs (a problem in obesity) and in no way gives a reliable image of the real axis deviation (17, 22). Using this parameter as the indication for surgical correction of genua valga can only give a cosmetic judgment. It may even mask a varus knee and induce an even more important varus due to stapling. The use of radiologic parameters is absolutely necessary (7, 19, 29). To minimise scar tissue formation, temporary epiphysiodesis can be achieved using a percutaneous screw, following Métaizeau's technique (21), which we are now using in our department. We still prefer a temporary hemi-epiphysiodesis with a screw to a definitive hemi-epiphysiodesis, as described by Bowen *et al* (4). The latter technique relies on skeletal age determination , which in our hands leaves too much place for error. On the other hand we have never seen a complete closure of the growth-plate after a temporary epiphysiodesis with a screw or a staple.

## REFERENCES


1. **Blount WP.** A mature look at epiphyseal stapling. *Clin Orthop* 1971 ; 77 : 158-163.
2. **Blount WP, Clarke GR.** The classic. Control of bone growth by epiphyseal stapling. *Clin Orthop* 1971 ; 77 : 4-17.
3. **Bonnevialle P, Durroux R, Cahuzac JP, Lebarbier P, Laville JM, Pasquie M.** Traitement des déviations frontales du genou par épiphyiodèse temporaire de Blount. *Rev Chir Orthop* 1982 ; 68 : 115-122.
4. **Bowen JR, Torres RR, Forlin E.** Partial epiphysiodesis to adress genu varum or genu valgum. *J Ped Orthop* 1992 ; 12 : 259-264.
5. **Bylander B, Selvik G, Hansson LI, Aronson S.** A Roentgen stereophotogrammetric analysis of growth arrest by stapling. *J Pediatr Orthop* 1981 ; 1 : 81-90.
6. **Cahuzac JP, Vardon D, Sales de Gauzy J.** Les déformations des membres inférieurs de l'enfant dans le plan frontal. *Ann Pédiatr* 1993 ; 40 : 230-236.
7. **Cahuzac JP, Vardon D., Sales de Gauzy J.** Development of the clinical tibiofemoral angle in normal adolescents. *J Bone Joint Surg* 1995 ; 77-B : 729-732.
8. **Chen SC.** Long term results of stapling of the knee. *Proc R Soc Med* 1970 ; 63 : 755-756.
9. **Duparc J, Massare C.** Mesures radiologiques des déviations angulaires du genou sur le plan frontal. *Ann Radiol* 1967 ; 10 : 635-656.

**10. Dutoit M.** Epiphysiodèse percutanée dans le traitement du genu valgum de l'adolescent. *Rev Chir Orthop* 1998 ; 84 : 623-627.

**11. Dutoit M.** L'agrafage selon Blount dans les déviations frontales idiopathiques des membres inférieurs chez l'enfant. *Chir Pédiatr* 1986 ; 27 : 103-107.

**12. Frantz CH.** Epiphyseal stapling : a comprehensive review. *Clin Orthop* 1971 ; 77 : 149-157.

**13. Fraser RK, Dickens DRV, Cole WG.** Medial physeal stapling for primary and secondary genu valgum in late childhood and adolescence. *J Bone Joint Surg* 1995 ; 77-B : 733-735.

**14. Greene WB.** Genu varum and genu valgum in children. *Instr Course Lect* 1994 ; 43 : 151-159.

**15. Heath CH, Staheli LT.** Normal limits of knee angle in white children. Genu varum and genu valgum. *J Ped Orthop* 1993 ; 13 : 259-262.

**16. Herwig J, Schmidt A, Matthiab HH, Kleemann H, Buddecke E.** Biochemical events during stapling of the proximal tibial epiphyseal plate in pigs. *Clin Orthop* 1987 ; 218 : 283-289.

**17. Hoet F.** Agrafage pour genu valgum essentiel. *Acta Orthop Belg* 1974 ; 40 : 255-284.

**18. Cozen L.** Knock-knee deformity in children. Congenital and acquired. *Clin Orthop* 1990 ; 258 : 191-203.

**19. Libri R, Sabetta E, Stilli S, Andrisano A.** The correction of valgus knee by temporary epiphyseal stapling. *J Ortop Trauma It* 1990 ; 16 : 221-228.

**20. McDonough MW.** Angular and axial deformities of the legs of children. *Clinics in Pediatry* 1984 ; 1 : 601-620.

**21. Métaizeau JP, Wong-Chung J, Bertrand H, Pasquier P.** Percutaneous epiphysiodesis using transphyseal screws (PETS). *J Ped Orthop* 1998 ; 18 : 363-369.

**22. Mielke CH, Stevens PM.** Hemiepiphyseal stapling for knee deformities in children younger than 10 years : a preliminary report. *J Ped Orthop* 1996 ; 16 : 423-429.

**23. Oudshoorn P, Mulder JD.** Kleine kwalen : genu varum en genu valgum bij kinderen. *Ned Tijdschr Gen* 1987 ; 131 : 11-12.

**24. Paley D, Tetsworth K.** Mechanical axis deviation of the lower limbs. *Clin Orthop* 1992 ; 280 : 48-56.

**25. Pistevos G, Duckworth T.** The correction of genu valgum by epiphyseal stapling. *J Bone Joint Surg* 1977 ; 59-B : 72-76.

**26. Stevens PM., Maguire M, Dales MD, Robins AJ.** Physeal stapling for idiopathic genu valgum. *J Ped Orthop* 1999 ; 19 : 645-649.

**27. Volpon JB.** Idiopathic genu valgum treated by epiphysiodesis in adolescence. *Int Orthop* 1997 ; 21 : 228-231.

**28. White GR, Mencio GA.** Genu valgum in children : diagnostic and therapeutic alternatives. *J Am Acad Orthop Surg* 1995, 3 : 275-283.

**29. Wildner M, Peters A, Hellich J, Reichelt A.** Complications of high tibial osteotomy and internal fixation with staples. *Arch Orthop Trauma Surg* 1992 ; 111 : 210-212.

**30. Zuege RC, Kempken TG, Blount WP.** Epiphyseal stapling for angular deformity at the knee. *J Bone Joint Surg* 1979 ; 61-A : 320-329.