

## Long-term results of leg length discrepancy treated with temporary epiphyseal stapling in children with juvenile chronic arthritis

E.T. Skyttä, H.A. Savolainen<sup>1</sup>,  
H.J. Kautiainen<sup>2</sup>, E.A. Belt<sup>2</sup>

*Surgical Department, Päijät-Häme Central Hospital, Lahti; <sup>1</sup>Pediatric Department and <sup>2</sup>Orthopaedic Department, Rheumatism Foundation Hospital (RFH), Heinola, Finland.*

*Please address correspondence to:  
Dr Eerik Skyttä, Päijät-Häme Central Hospital FIN-15850 Lahti, Finland.  
E-mail: eerik.skytta@phks.fi*

*Received on October 2, 2002; accepted in revised form on March 11, 2003.*

*© Copyright CLINICAL AND EXPERIMENTAL RHEUMATOLOGY 2003.*

**Key words:** Juvenile chronic arthritis, leg length discrepancy, temporary epiphyseal stapling.

### ABSTRACT

**Objective.** The aim of the present study was to evaluate retrospectively the long-term efficacy of temporary stapling of the knee epiphyses over four decades of use in children with JCA.

**Methods.** Medical data of the patients with temporary epiphyseodesis due to leg length discrepancy (LLD) were studied. Seventeen knees in 17 patients were found with sufficient follow-up data for evaluation. Patient documents and radiographs of these patients were evaluated.

**Results.** The mean age at the time of the operation was 11 years (range: 6–15) in 3 males and 14 females. The pre-operative mean LLD was 21 mm (SD 8) and at staple removal 4 mm (SD 10). The difference was -17 mm (95 % CI: -10 to -23). Statistically the result remained the same during the follow-up. Two reversible complications were documented among the 17 stapled knees. In five (29%) cases the correction was affected by re-occurrence of LLD quickly after removal of the staples.

**Conclusion.** In this study with 17 patients and a wide range of follow-up times we found that the good correction of LLD achieved by stapling is usually permanent.

### Introduction

Blount and Clarke introduced temporary epiphyseal arrest with staples in the management of knee malalignment in 1949 (1). The incidence of juvenile chronic arthritis (JCA) in Finland is 13.5 to 18.2 per 100,000 per year (2, 3). The arthritis most commonly affects the knee joint (4, 5), and the inflammation has been shown to cause increased blood flow and growth acceleration in knee epiphyses (6–8). A few studies on stapling in the management of knee malalignment in children with JCA have been published (9–14). The safety and effectiveness of temporary epiphyseal stapling in the management of leg length discrepancy (LLD) in patients with JCA has been shown (15), but the long-term results have thus far been unclear. The importance of prompt follow-up has been emphasised due to difficulties in predicting the remaining

growth and correction potential.

In a previous study, we evaluated trends in the use of temporary stapling of the knee epiphyses in the management of LLD in children with JCA, and assessed the short-term safety and efficacy of the method (15). The present study is a sub-group analysis of our previous cohort, and the aim was to retrospectively evaluate the long-term efficacy of temporary stapling of the knee epiphyses over four decades of use in children with JCA.

### Patients and methods

According to a previous study 76% of Finnish children with JIA were treated at the Rheumatism Foundation Hospital (RFH) in the 1980s (3). In earlier decades the proportion was somewhat lower. Complete records on operative treatment at RFH were collected to identify patients with JCA who had undergone temporary epiphyseal stapling of the knee due to LLD during 43 years after the founding of RFH. All synovectomies, arthrodeses, arthroplasties and intra-articular steroid injections to these patients were solely performed at RFH, including those having taken place prior to stapling.

The first temporary arrest of epiphyseal growth at RFH for the management of LLD was performed on 3 October 1957, and up to the end of 1999 a total of 71 patients had undergone the procedure. All of these patients were included in the present retrospective study and during the examination period a total of 76 knees were stapled, 5 of the procedures being re-operations due to recurrence. The re-operations were excluded, giving 71 primary operations altogether.

Subsequently, the medical records of the operated patients were evaluated to examine the indications of stapling; the diagnostic criteria were settled according to the proposition by European League Against Rheumatism (EULAR, ref. 16). During the decades the indication for stapling has varied according to the orthopaedist. In the earlier years LLDs up to 15–18 mm had been tolerated. In the recent years some pubertal patients with LLD less than 10 mm were operated on, especially if during

**Table I.** Distribution of diagnoses in the study group.

Diagnosis	All patients No. (%)
Systemic arthritis	1 (6)
Polyarthritis	
RF-positive	0 (0)
RF-negative	4 (23)
Oligoarthritis extended	12 (71) 3 (18)
Psoriatic arthritis	0 (0)
Other arthritis	0 (0)
Total	17 (100)

**Table II.** Distribution of stapling methods used.

Method of stapling	All patients N (%)
FM2-FL2	9 (53)
FM2-FL2-TM2-TL2	1 (6)
FM2-FL2-TM2-TL1-Fi1	3 (17)
FM2-FL2-TM1-TL1-Fi1	1 (6)
FM2-FL2-TM1-TL1	1 (6)
TM2-TL1-Fi1	2 (12)
Total	17 (100)

F: femur; T: tibia; Fi: fibula; M: medial side; L: lateral side; 1 – 3 = number of staples inserted.

the follow up there had been no signs of a spontaneous correction of LLD.

For the purpose of this retrospective study, medical data of the patients with temporary epiphyseodesis due to LLD were studied, and the following variables were recorded: sex, age at onset of arthritis, diagnosis, age at operation, pattern of stapling and all the complications related to stapling. The end-point was set at the end of the patient's growth period verified by subsequent similar length measurements, level of alkaline phosphatase and closure of the epiphyseal plates on plain roentgenograms. All synovectomies, arthrodeses, arthroplasties and intra-articular steroid injections prior to stapling and during follow-up were recorded. LLD was evaluated by clinical measurement from the anterior iliac spine to the medial malleolus and by standing roentgenograms with a radiographic grid, and was recorded at three time points: before stapling, at the time of staple removal and at the end-point, as were the length of stapling and follow-up periods. Seventeen knees were found with sufficient follow-up data for evaluation.

The results are expressed as the mean and standard deviation (SD). Statistical comparison of changes was performed using repeated-measures analysis of

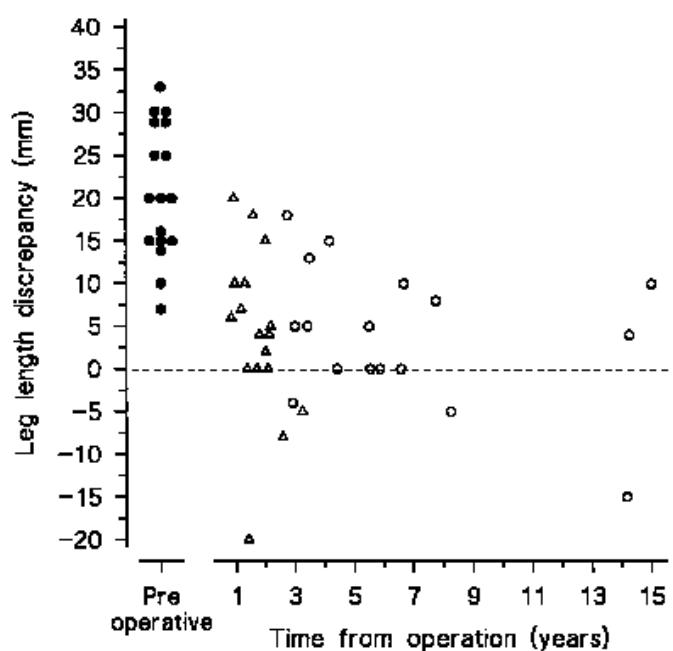
variance (RANOVA) and the paired t-test. The normality of variables was evaluated by the Shapiro-Wilk test.

## Results

Distribution of the procedures was 8 right and 9 left knees in 3 males and 14 females, respectively. The mean age at the time of operation was 11 years (range: 6 – 15). The mean duration of the disease by the time of the operation was 7 years (range: 1 – 14). The distribution of patients into different diagnostic categories according to the EULAR criteria is presented in Table I. The number of patients with oligoarthritis developing to polyarthritis (extended oligoarthritis) is shown in the table.

Most of the knees (9/17) were stapled only at the distal femoral epiphysis using 2 vitallium staples both medially and laterally; other patterns are shown in Table II. The average age of the patients was 11 (8 – 15) years at the time of temporary epiphyseodesis and 17 (13 – 26) years at the end-point. In 5 cases additional staples were inserted on the medial and lateral aspects of the proximal tibial epiphysis; the average age of these patients was 11 (6 – 15) years. Two operations with stapling of the proximal tibia were also performed; the ages of these patients were 8 and 10 years. The median stapling period of the cohort was 19 (10 – 39) months. The median follow-up time was 68 (33 – 180) months.

The pre-operative mean LLD was 21 mm (SD 8) and at staple removal 4 mm (SD 10). The difference was -17 mm (95 % CI: -10 to -23), ( $p < 0.001$ ). Statistically the result remained the same during the follow up. The results are presented in Figure 1. In one case the leg length discrepancy (left leg longer prior to operation) was over-corrected to -5 mm, and the long term result was an over-correction to -15 mm. The girl was 8 years old at the time of operation and she subsequently developed both right knee arthritis and left subtalar arthrosis which was treated with subtalar arthrodesis. The other case with grave over-correction to -20 mm was also due to an aggressive contralateral gonarthrosis. Spontaneous correction to



**Fig. 1.** Correction of leg length discrepancy. ● show pre-operative leg length discrepancy (LLD), ▲ show LLD by the time of staple removal and ○ show LLD after follow-up.

-15 mm occurred during follow-up in her case.

In 5 (29 %) of the 17 cases the correction was partially lost by recurrence of discrepancy soon after removal of the staples. The rebound was measured at a random interval (shortest 4 months) and the mean was 8 mm (4 – 15).

Two (12% [ 95% CI: 1 to 36 ]) major complications were documented among the 17 stapled knees. The one case with peroneal paralysis (in this patient the fibula was also stapled) was treated with success surgically. In the other case with staple mislocation, the staples were simply re-inserted without delay. A total of 43 pre-operative knee synovectomies were documented in the study group, two being arthroscopical, 17 open and 24 chemical (with osmic acid or sodium salts of fish oil). Of these, 10 open and 16 chemical synovectomies were on the side of the temporary epiphyseal stapling. A total of 343 local intra-articular steroid injections were administered in the cohort, 116 of which during the 143 patient years of follow-up. Eighty-two of the injections were given prior to stapling in the knee to be stapled and 27 after the operation in the stapled knee. In addition to the aforementioned subtalar arthrodesis, there was another ipsilateral subtalar fusion, and one patient underwent an ipsilateral total knee arthroplasty 9 years after stapling.

## Discussion

In this retrospective study with 17 patients and a long follow-up period we found that the good correction of leg length discrepancy achieved by stapling is usually permanent. This is in concordance with clinical experience. We recommend temporary epiphyseal stapling in the management of leg length discrepancy in children with chronic arthritis. Present results as well as our previous study confirm the safety and efficacy of this technique, and the permanence of the correction. Compared to lengthening or shortening osteotomy in adulthood, stapling is clearly easier for the patient. Therefore we suggest a prompt follow-up of knee alignment dis-

turbances in all patients with chronic arthritis. This is especially important during the period of rapid growth in adolescence, since at this growth point the stapling is most effective.

It is imperative to control the synovitis in the knees in order to gain the best results from stapling. The high number (82) of glucocorticoid injections given to the knees to be stapled and the number of synovectomies indicate the chronicity of arthritis which led to LLD. In some cases the arthritis continued even after the operation: 27 injections were given in the stapled knees. The post-operative injections were administered in an attempt to calm the arthritis, and by so doing to prevent a recurrence of LLD. This must be borne in mind while planning the follow-up of LLD. Especially in cases with ipsi- or contralateral active gonarthritis, the follow-up must be at short intervals.

In 5 (29 %) of the 17 cases we found evidence of rebound leg length discrepancy, i.e. shortly after removal of the staples there seemed to be a period of growth acceleration at the stapled extremity. Whether this was due to inflammation of the stapled knee or some other ipsi- or contralateral lower extremity joint, or actual rebound growth acceleration remains uncertain and calls for structured prospective study. By removing the staples after slight over-correction, the recurrence of LLD due to rebound may be controlled. The authors' preferred method is to insert the staples at a discrepancy exceeding 10 mm and to remove the staples at slight over-correction. In order to avoid staple mislocation, the operation should be conducted under fluoroscopic guidance. Anterior or posterior mislocation may cause ante- or recurvatum. Cranial or caudal mislocation may damage the knee joint or at worst penetrate the growth plate and cause premature closure. Each pair of staples should be inserted through a short, separate skin incision in order to achieve the best cosmetic result. The number of staples is to be decided individually, but based on experience we prefer two staples on both sides of the

epiphyseal plate in either the distal femur only or both the distal femur and the proximal tibia.

## References

1. BLOUNT WP, CLARKE GR: Control of bone growth by epiphyseal stapling; a preliminary report. *J Bone Joint Surg [Am]* 1949; 31: 464-78.
2. KUNNAMO I, KALLIO P, PELKONEN P: Incidence of arthritis in urban Finnish children. *Arthritis Rheum* 1986; 29: 1232-8.
3. KAIPIAINEN-SEPPÄNEN O, SAVOLAINEN A: Incidence of chronic juvenile rheumatic diseases in Finland during 1980-90. *Clin Exp Rheumatol* 1996; 14: 441-4.
4. BRATTSTRÖM M, SUNDBERG J: Juvenile rheumatoid gonarthritis. I. Clinical and roentgenological study. *Acta rheumatol Scand* 1965; 11: 266-78.
5. ANSELLBM: Joint manifestation in children with juvenile chronic polyarthritis. *Arthritis Rheum* 1977; 20 (Suppl.): 204-6.
6. BRODIN H: Longitudinal bone growth. The nutrition of the epiphyseal cartilages and the local blood supply. *Acta Orthop Scand* 1955-56; Suppl. 20: 1-92.
7. SUNDBERG J, BRATTSTRÖM M: Juvenile rheumatoid gonarthritis. II. Disturbance of ossification and growth. *Acta Rheumatol Scand* 1965; 11: 279-90.
8. BRATTSTRÖM M: Asymmetry of ossification and rate of growth of long bones in children with unilateral juvenile gonarthritis. *Acta Rheumatol Scand* 1963; 11: 103-15.
9. RYDHOLM U, BRATTSTRÖM H, BYLANDER B, et al.: Stapling of the knee in juvenile chronic arthritis. *J Pediatr Orthop* 1987; 7: 63-8.
10. ARDENGOP: Surgical treatment of Still's disease (juvenile chronic arthritis). *Ann Acad Med Singapore* 1983; 12: 174-84.
11. 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]* 1995; 5: 733-5.
12. LAINE H, MIKKELSEN OA: Epiphyseal stapling in juvenile rheumatoid gonarthritis. *Acta Rheumatol Scand* 1968; 14: 317-22.
13. MIELKE CH, STEVENS PM: Hemiepiphyseal stapling for knee deformities in children younger than 10 years: A preliminary report. *J Pediatr Orthop* 1996; 16: 423-9.
14. ZUEGE RC, KEMPKEN TG, BLOUNT WP: Epiphyseal stapling for angular deformity at the knee. *J Bone Joint Surg [Am]* 1979; 61: 320-9.
15. SKYTTÄ E, SAVOLAINEN A, KAUTIAINEN H, BELT E: Treatment of leg length discrepancy in children with juvenile idiopathic arthritis during 1957-99. *J Paediatr Orthop* 2003; 23: 378-80.
16. WOOD PHN: Nomenclature and classification of arthritis in children. In MUNTHE E (Ed.): *The Care of Rheumatic Children*. 1978 EULAR Monograph series No. 3. EULAR Publishers, Basle: 47-50.