

Stapling for tibial-growth deformity

A case report on roentgen stereophotogrammetric analysis

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A 9-year-old boy sustained a Salter-Harris Type IV fracture in the proximal tibia. The injury resulted in a progressive valgus deformity, detected already after 3 months by roentgen stereophotogrammetry. After temporary stapling medially, the growth rate increased laterally and the deformity was corrected. Unilateral stapling is an alternative procedure for correcting angular deformity following a physal injury.

The identification of a condensed area or a defect in the growth region by standard radiographs and tomography has been interpreted as a bony bridge between the metaphysis and bony epiphysis (Ford and Key 1956, Rang 1969, Langenskiöld 1975). Previous studies have been contradictory regarding continuous growth capacity after this finding (Campbell et al. 1959, Johnson and Southwick 1960, Nordentoft 1969).

Using roentgen stereophotogrammetry, we followed the growth of the proximal tibia in a 9-year-old boy after a Salter Harris Type IV fracture. He was followed for 6 years until completion of growth.

Case report

A boy, aged 8 years and 8 months, was run over by a tractor and sustained a Salter Harris Type IV fracture through the lateral part of the proximal growth plate in the left tibia (Figure 1) and a fracture through the proximal fibular metaphysis. The tibial fracture was reduced and fixed with a pin. After 5 weeks, the pin was extracted and 0.5-mm tantalum balls were inserted in the proximal tibia bilaterally. At least three balls were inserted on each side of the injured growth plate, permitting measurement of the three-dimensional growth (Selvik 1974). The boy was then followed with roentgen stereophotogrammetric examinations until completion of growth. The error of the longitudinal growth calculations is about 30 μm and that of the three-di-

mensional calculations about 0.2° (Selvik 1974, Aronson 1976).

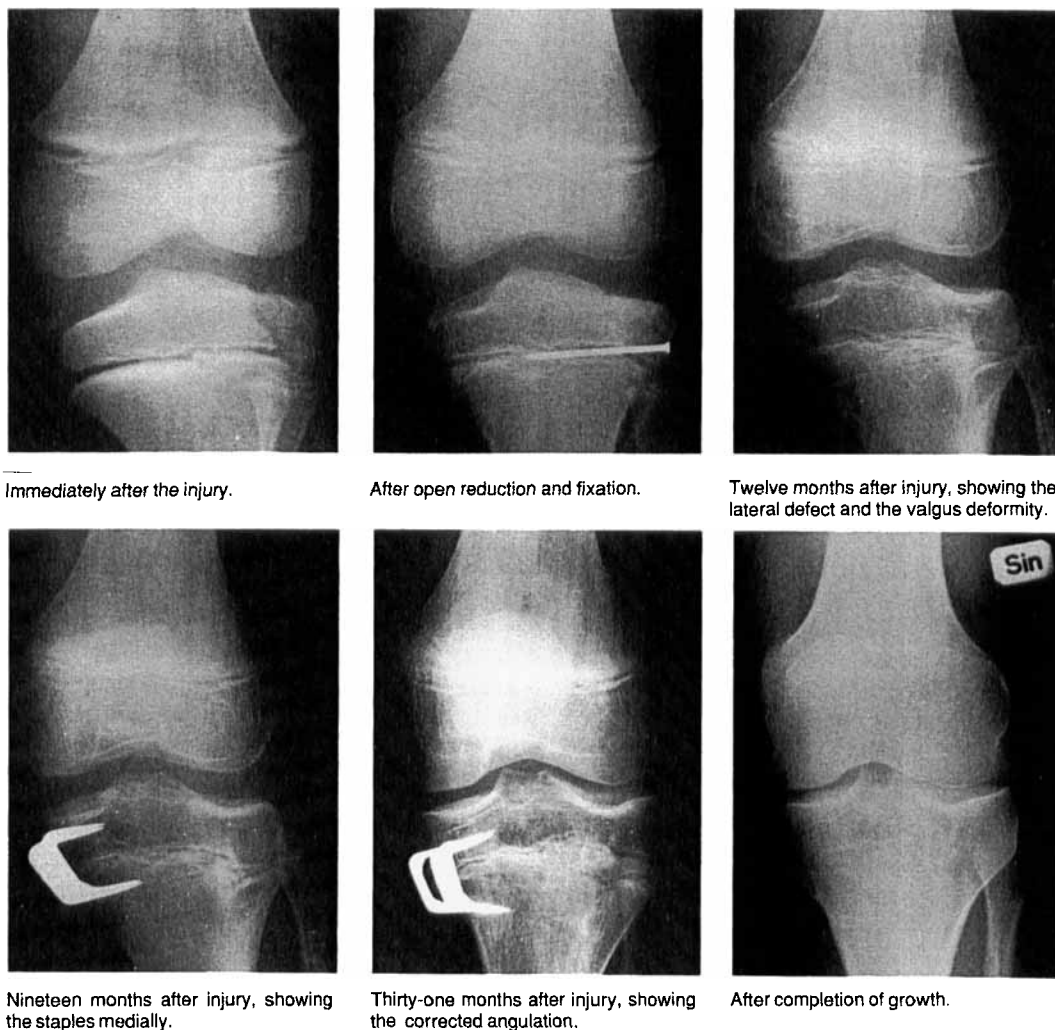
After 3 months, a progressive valgus deformity was evident by the roentgen stereophotogrammetric analysis. Further measurements also revealed an increasing antecurvature and outward torsion (Figures 2 and 3). The standard radiographs showed a condensed area in the lateral part of the injured growth plate, indicating a bony bridge or an osseofibrous connection between the bony epiphysis and metaphysis. The roentgen stereophotogrammetric analysis showed a continuous decrease in the growth rate as compared with the right proximal tibia. The decrease was more pronounced laterally.

After 19 months, staples were inserted medially over the growth plate. The boy was allowed immediate full weight bearing.

Further examinations showed that the progression of valgus and antecurvature deformity was interrupted and reversed. The growth rate over the lateral part of the left growth plate increased after the stapling from 7 $\mu\text{m}/\text{day}$ to 20–30 $\mu\text{m}/\text{day}$, similar to the right knee. The growth rate over the medial part of the left growth plate decreased after stapling to less than 5 $\mu\text{m}/\text{day}$, but with time increased to 10–12 $\mu\text{m}/\text{day}$. This corresponded to a widening of the staples. Standard radiographs 1 year after the stapling showed the condensed area displaced in the metaphyseal direction.

Twenty-one months after the stapling, as a sign of overcorrection, a varus and retroversion were seen (Figure 3). Nine months later, the staples were extracted. After the extraction, the growth rate was similar on both sides of the growth plate. Completion of growth occurred simultaneously in both knees at 15 years of age and resulted in clinically straight legs.

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Immediately after the injury.

After open reduction and fixation.

Twelve months after injury, showing the lateral defect and the valgus deformity.

Nineteen months after injury, showing the staples medially.

Thirty-one months after injury, showing the corrected angulation.

After completion of growth.

Figure 1. A 9-year-old boy with a Salter Harris Type IV fracture in his left knee.

Discussion

The radiographic sign of a bony bridge or an osseofibrous connection in the growth region after a physal injury indicates a growth disturbance. However, from clinical and routine radiographic examinations, it is difficult to predict the future development. Several attempts have been made to classify physal fractures in order to predict growth disturbances (Bergensfeldt 1933, Salter and Harris 1963, Aitken 1965, Tachdjian 1972). The classifications are similar, and the prognostic validity is mainly based on animal experiments. The prognostic value of the classification system of Salter and Harris has been questioned (Lombardo and Harvey 1977, Ogden 1981). The roentgen stereophotogrammetric analysis permits accurate determination

of longitudinal growth and rotational movements over short periods, making prediction possible and facilitating early treatment of deformities (Aronson 1976, Selvik 1974, Bylander et al. 1981).

Many methods to treat angular deformity after physal injuries have been described. Surgical procedures such as the Langenskiöld (1967, 1975) operation, distraction physiolysis (Monticelli and Spinelli 1981), osteotomies (Rang 1969, Tachdjian 1972), and stapling (Blount 1971) have been described. Spontaneous correction may occur, but it is not common (Chadwick 1982).

After Salter Harris Type IV injuries, a growth disturbance, often with radiographic signs of a bony bridge, is a regular finding (Salter and Harris 1963, Lombardo and Harvey 1977, Bylander et al. 1981). In our case an

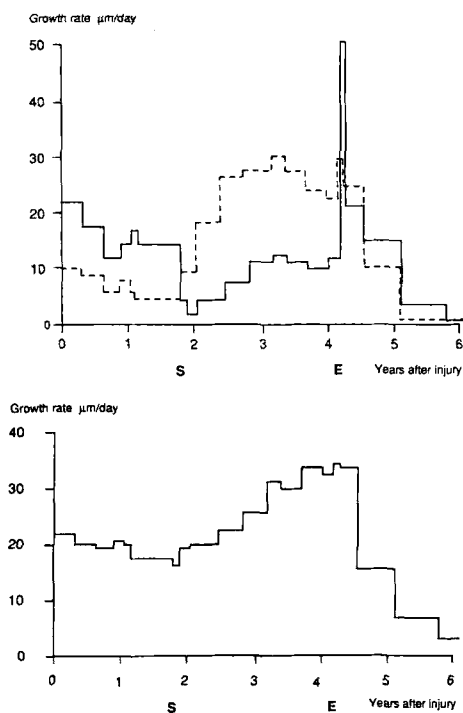


Figure 2. Longitudinal growth of the left (top) and the right (bottom) proximal tibia. S stapling, E extraction of staples, --- lateral part of left knee, — medial part of left knee.

area of condensed bone was seen. However, growth was recorded by roentgen stereophotogrammetry during the entire investigative period, indicating that the defect was osseofibrous rather than a bony bridge between the bony epiphysis and metaphysis.

The evidence of continued growth laterally was

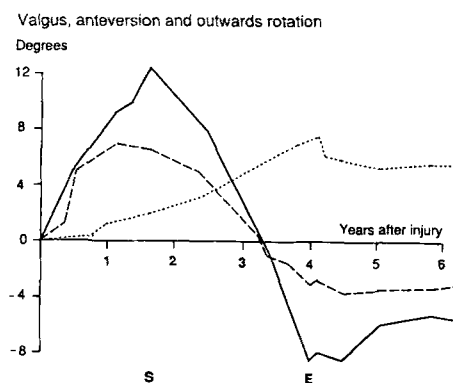


Figure 3. Angulation of the left proximal tibia. Rotation of the metaphysis in relation to the bony epiphysis. S and E as in Figure 2. — valgus, --- anteversion, torsion outwards.

the basis for the decision to insert medial staples in this patient. The staples compressed the medial physis and thereby reduced the medial growth. Then, the intact growth plate surrounding the osseofibrous defect could distend the defect exerting greater force than before, resulting in increased lateral growth. After the stapling procedure, the area of condensed bone appeared to gradually move distally. This was the result of continued growth proximally and probable regeneration of the growth plate in the earlier defect.

We conclude that unilateral stapling may correct angular deformities after physal injuries with partial growth disturbance.

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