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Late results in 65 physeal ankle fractures

Fifty-nine Salter-Harris III and IV lesions of the medial malleolus, Tillaux fractures, and triplane fractures were examined after 9 (3–32) years to assess the frequency of late symptoms, deformity, joint incongruity, and secondary arthrosis. Six out of 18 Salter-Harris III and IV lesions of the medial malleolus were reduced open, none of which had any signs of growth disturbance, whereas 1 case, left with a 3-mm residual dislocation, had 5 degrees of anterior angulation. Of the 17 Tillaux fractures, ten were not reduced and two of these gave slight symptoms, whereas five openly reduced fractures were asymptomatic at follow-up. Out of 18 triplane fractures, not reduced, two gave slight ankle pain and another had 6 degrees of anterior angulation, whereas three of ten reduced fractures were symptomatic.

The overall results were good and no case of arthrosis, defined as reduction of the joint space, was found in any of the fracture groups despite a follow-up of 12 or more years in one third of the cases.

Lennart A. Landin
Lars G. Danielsson
Kjell Jonsson
Holger Pettersson[1]

Lund University Departments of Orthopedics and [1]Diagnostic Radiology at Malmö General Hospital, S-214 01 Malmö, Sweden

Late deformity, joint incongruity, and growth disturbance following physeal fractures of the distal tibia are well known and feared complications (Blount 1955, Carothers & Crenshaw 1955). Varus deformity has been recognized as a risk after fracture of the medial malleolus because of growth deceleration of the medial part in the distal tibial growth plate and subsequent overgrowth of the lateral part (McFarland 1931, Gill & Abbott 1941, Langenskiöld 1967, Kärrholm et al. 1983). Using stereophotogrammetric analysis, Kärrholm et al. (1983) found various patterns of interference with growth after physeal fractures of the ankle in childhood and adolescence. The pattern of growth interference was, however, inconsistent. The prognostic value of the Salter-Harris classification was regarded as insignificant in their study, with a maximum follow-up of 4 years. However, in a roentgenographic follow-up of 184 patients with fractures of the distal end of the tibia and fibula, Spiegel et al. (1978) found that Salter-Harris Type III and IV tibial fractures with 2 mm or more of displacement, juvenile Tillaux fractures, triplane fractures, and comminuted tibial epiphyseal Type V fractures had complications in one third of the cases.

We have determined the incidence of late deformity, joint incongruity, and associated persisting symptoms following intraarticular physeal distal tibial fractures during childhood and adolescence and correlated these sequelae with the fracture type, age at fracture, degree of dislocation, and type of treatment.

Patients and methods

From a material of 373 ankle fractures in children aged 3–16 years, all 78 patients with Salter-Harris lesions Types III and IV of the medial malleolus, Tillaux fractures (Salter-Harris III of the anterolateral part of the distal tibial epiphysis) and triplane fractures (Salter-Harris II-IV) were selected for follow-up. Fifty-nine out of these 78 patients came for a complete clinical and radiographic follow-up 9 (3–32) years later. In addition, 6 patients stated that they had no residual symptoms and, therefore, refused follow-up, so that information was obtained from totally 65 of the cases (Table 1). In the remaining group, lost for follow-up, there was 1 death, 5 patients who had emigrated, and 7 who could not be traced.

In each case the initial dislocation, treatment, and residual dislocation were recorded. Concomitant physeal fractures of the lateral malleolus could not be diagnosed with certainty because these injuries most often are minimally displaced and have to be examined with stress radiographs, or at least with views of the unaffected ankle for comparison; these methods were not applied routinely. In the cases openly reduced, internal fixation was carried out

Table 1. Physeal ankle fractures

Fracture type	Case	Age at accident	Sex	Follow-up (yr)	A	B	C	Symptoms	Clinical findings	Radiography[a]	Remarks
Salter-Harris type III lesions of the medial malleolus, n=14	1	15	M	22	2	2	n	0	0	0	
	2	15	M	12	1	1	n	0	0	0	
	3	16	M	7	3	1	o	0	0	0	
	4	15	M	6	3	1	o	0	0	Fx r tib +15 mm	Mb Perthes left, left leg −3 cm
	5	12	M	6	1	1	n	0	0	0	
	6	14	M	6	2	2	n	0	–	–	
	7	10	F	6	3	1	o	0	0	0	
	8	16	F	6	2	0	o	0	0	0	
	9	12	F	5	1	1	n	0	0	0	
	10	15	M	5	3	0	o	0	–	–	
	11	8	F	4	1	1	n	0	0	0	The distal tibial physis open at follow-up
	12	13	M	4	1	1	n	0	0	0	
	13	15	F	3	1	1	n	0	0	0	
	14	15	M	3	1	1	n	0	0	0	
Salter-Harris type IV lesions of the medial malleolus, n=6	15	13	F	27	1	1	n	0	0	0	
	16	15	M	22	3	3	n	0	0	ant 5°	
	17	14	F	17	1	1	n	+	Dorsiflexion-10°	0	
	18	16	M	6	7	3	o	0	0	0	
	19	13	M	6	1	1	n	0	0	0	
	20	14	M	5	3	0	o	0	0	0	
Tillaux fractures, n=17	21	15	F	27	3	2	c	0	0	0	
	22	13	F	22	2	2	n	0	–	–	
	23	14	F	17	1	1	n	0	0	0	
	24	13	F	12	8	0	o	0	0	0	
	25	14	F	12	2	2	n	0	0	0	
	26	13	F	12	2	2	n	0	0	valgus 15°,tib−17 mm	Fig. 1
	27	16	M	7	2	2	n	0	0	0	
	28	12	F	6	5	0	o	0	0	0	
	29	15	M	6	1	1	n	0	0	0	
	30	15	M	6	2	2	n	0	0	0	
	31	13	F	6	9	0	o	0	0	0	
	32	14	F	5	10	0	o	0	0	0	
	33	14	F	5	2	2	n	+	0	0	
	34	16	F	5	2	2	n	0	0	dor 6°	
	35	14	F	4	4	0	o	0	0	0	
	36	14	F	4	2	2	n	+	0	ant 5°	
	37	12	F	3	11	0	o	0	–	–	
Triplane fractures, n=28	38	16	M	32	7	7	n	0	0	0	Fx fib
	39	14	F	32	2	2	n	0	0	0	
	40	13	F	22	3	3	o	0	0	0	Fx fib
	41	16	M	12	16	1	o	0	0	0	Fx fib
	42	13	F	12	2	2	n	0	0	0	Fx fib
	43	13	M	12	2	2	n	0	0	0	
	44	15	M	12	4	4	n	0	0	0	Fx fib
	45	13	M	12	2	2	n	0	0	0	
	46	15	M	12	1	1	n	0	–	–	Fx fib
	47	13	F	7	9	0	c	+	0	0	
	48	15	M	7	1	1	n	0	0	0	
	49	11	F	6	1	1	n	+	0	0	
	50	11	F	6	2	2	n	+	0	0	
	51	16	M	6	10	0	c	0	0	0	
	52	10	F	6	1	1	n	0	0	0	
	53	13	M	5	1	1	n	0	0	ant 6°	
	54	16	F	5	2	2	n	0	0	0	
	55	16	F	5	6	4	c	0	0	0	
	56	13	F	5	1	1	n	0	0	0	
	57	14	F	5	9	4	c	0	–	–	Fx fib
	58	13	F	4	14	3	o	0	0	0	Fx fib
	59	11	M	4	1	1	n	0	0	0	
	60	16	M	4	10	4	c	+	0	varus 6°	Fig. 2
	61	14	M	3	3	2	o	0	0	0	Fx fib
	62	13	F	3	1	1	n	0	0	0	
	63	16	M	3	1	1	n	0	0	0	
	64	16	F	3	6	1	o	+	0	ant 10°	Fx fib
	65	13	F	3	2	2	n	0	0	0	

A. Initial dislocation (mm). B. Residual dislocation (mm). C. n = no reduction; c = closed reduction; o = open reduction. Discrepancies in ankle or subtalar joint motion less than 10 degrees, calf circumference less than 1 cm, tibial length discrepancy less than 10 mm and angulatory deformity less than 5 degrees have not been stated. The lack of clinical and radiological findings in the cases who refused follow-up is marked with –. [a] ant = anterior angulation, dor = dorsal angulation. Cases 17, 33, 36, 47, 49, 50, 60 and 64 had slight pain after exertion. The fibular fractures in the triplane fracture group were all localized above the syndesmosis.

with thin pins or K-wires. All fractures, either reduced or not, were immobilized in lower leg plaster casts for 4–6 weeks. Twenty-eight cases had fracture lines in three planes – sagital through the epiphysis, transverse through the physis, and in the metaphyseal region a fracture line in the frontal plane. Apart from the original triplane fracture type, described by Marmor (1970) and Lynn (1972) (Figure 2), there were also fractures similar to those described by Cooperman et al. (1978) and Kärrholm et al. (1981). In this group the fracture pattern was not as uniform as in the other groups, and therefore the degree of dislocation was measured at the point of maximum, which in some cases was in the metaphyseal region and not between the intraarticular fragments.

In 41 cases the fractures were caused by minor trauma, e.g., falling to the ground from standing on the same level; most sports injuries belonged to this group. Moderate trauma – falling from heights 0.5–3 meters and bicycle injuries – was encountered in 16 cases, and severe trauma – traffic accidents and falls from heights more than 3 meters –w as the cause of fracture in 5 cases. The degree of energy in the causative trauma could not be determined in 3 cases.

A history with emphasis on pain, tendency toward swelling, and restriction of activities was obtained at follow-up, and the range of motion of the ankle and the subtalar joints was recorded. The clinical examination also included measurements of the calf circumference, swelling, rotational and angulatory deformities, and signs of instability.

The radiographic examination was performed with standard AP and lateral views of both ankles with a film focus distance of 120 cm. The lower legs were examined in anteroposterior projection with the knee and ankle joints on the same film, so that angular deformity and tibial length discrepancy could be measured. The height of the joint space was determined at six measuring points in the previously fractured ankle, as well as in the unaffected ankle, according to the method of Jonsson et al. (1984). All radiographic follow-up measurements were made without knowledge of the type of fracture or side involved.

Results

From census data, we calculated that our study covered 482,439 child risk years, with an annual fracture incidence of 1.64/10,000 in age-groups 0–16.

No case of osteoarthrosis, defined as reduction of the joint space, was found in any of the fracture groups. Except for removal of implants used for internal fixation, surgery had not been performed in any case because of late complications. No correlation between age at fracture and long-term complications could be demonstrated in this series.

Salter-Harris Type III medial malleolus lesions

All 14 patients in this group were asymptomatic, and no clinical or radiographic abnormalities associated with the ankle fracture were found in any of the 12 patients who had a complete check-up.

Salter-Harris Type IV medial malleolus lesions

One of the 6 patients in this group had pain in the previously fractured ankle and lacked 10 degrees of dorsiflexion, but the ankle was radiographically normal. In another patient, who had no ankle pain, radiographic examination showed 5 degrees of anterior angulation.

Tillaux fractures

Two patients in this group of 17 cases had slight ankle pain; radiographic examination of these 2 cases showed 5 degrees of anterior angulation in 1 and no abnormality in the other case. One asymptomatic patient had 6 degrees of dorsal angulation and another had a valgus deformity of 5 degrees and 17 mm of tibial shortening (Figure 1). All 4 cases, either symptomatic or with radiographically abnormal ankles, had sustained fractures that were treated without reduction and left with 2 mm of dislocation.

Triplane fractures

Five patients in this group of 28 cases had minor symptoms in the previously fractured ankle, but all of them were normal clinically. One of these 5 patients had a varus deformity of 6 degrees (Figure 2) and another had 10 degrees of anterior angulation. One patient with 6 degrees of anterior angulation at follow-up had no ankle symptoms. In this group there was no correlation between the residual fracture dislocation and late results.

Discussion

The ankle fracture types studied here are considered to be high risk fractures as regards late

A

B

Figure 1. Case 26. A 13-year-old girl with a Tillaux fracture, treated by closed reduction.
A. Fractured right ankle, showing that the medial part of the physis is still open.
B. Follow-up at 12 years revealed 17 mm of shortening and 5 degrees of valgus. Although the remaining growth potential must have been small, there was no other apparent cause for differences between the two sides.

complications, but our overall results did not substantiate this. Despite the intraarticular involvement and the long 12-year or more follow-up in 20 of 59 patients, there was no case with radiographic signs of joint cartilage degeneration. Factors contributing to this favorable outcome could be that the majority of fractures were left with only minor residual displacement and that most fractures of these types occur at an age when the remaining growth potential of the physis is small, which makes the importance of premature growth arrest less significant.

Further, most of the injuries were caused by low-energy trauma. No correlation was found between the end result and the degree of traumatic severity. However, it is possible that higher frequencies of growth disturbances can be found in fractures of the same appearance, but caused by more severe trauma, thus increasing the risk of extensive damage to the germinal cells of the physis.

Only 8 patients had symptoms following their injury, and ankle pain was regarded as minor by all the patients. In 4 of these cases, the ankles were clinically and radiographically normal. Angulation deformities were found in 3 symptomatic cases – Cases 36, 60 (Figure 2), and 64 – but also in the 4 asymptomatic cases 16, 26 (Figure 1), 34, and 53, which indicates the possibility of a normal side variation. Spiegel et al. (1978) found evidence indicating that displaced Type III and IV fractures of the medial malleolus, Tillaux and triplane fractures are all associated with a high risk of growth disturbances, such as premature and/or asymmetric physeal closure, resulting in shortening of the leg of 1 centimeter or more, residual joint incongruity, and angular deformity in any plane of 5 degrees or more, or a combination of these. In their series of 28 patients, one third had radiographic signs of skeletal complications. However, the clinical importance and risk of developing secondary arthrosis has not been estabished yet. In our investigation, radiographic abnormalities were found in only 8 of 59 patients belonging to the same high risk group. However, only three of these eight ankles were symptomatic, and the symptoms were regarded as minor by all the patients.

The majority of symptomatic ankles had had a Tillaux or triplane fracture. Cooperman et al. (1978) also found that 3 out of 14 patients with triplane fractures had radiographic evidence of premature symmetric physeal closure with less than 0.5 cm of shortening on an average of 2 years after injury. In our Tillaux group, 4 of 17 patients either had symptoms or radiographic signs of complications; all four fractures were initially only slightly displaced, 2 mm or less, and reduction was not attempted. In spite of the greater initial displacement, the five fractures treated with open reduction and internal fixation were asymptomatic and clinically and

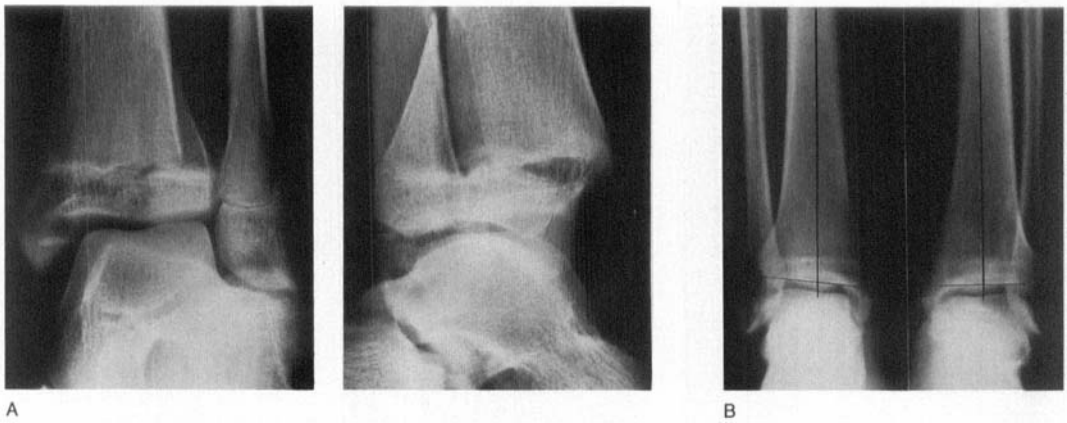

Figure 2. Case 60. 16-year-old boy with a triplane fracture of the type originally described by Lynn (1972), treated by closed reduction with 4-mm residual dislocation. A. At injury. B. After 4 years. The fractured ankle has a residual varus deformity of 6 degrees as compared with the unaffected right ankle. The patient had pain in the ankle after running long distances.

radiographically normal. Excellent position was achieved, and this finding suggests that Tillaux fractures should be exactly reduced, preferably with open reduction and pin fixation.

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