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Fracture dislocations of Lisfranc's joint treated with closed reduction and percutaneous fixation

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Abstract We reviewed 42 patients (mean age 37.7±14.2 years) with closed fracture dislocations of Lisfranc's joint treated with percutaneous screw fixation. Mean follow-up was 58.4±17.3 months. The aim was to compare dislocations in which a perfect anatomical reduction had been reached with dislocations in which reduction was only near anatomical. The mean American Orthopaedic Foot and Ankle Society score for all patients was 81.0±13.5. There were no significant differences in outcome scores between patients with perfect anatomical reduction and patients with near anatomical reduction. However, patients with combined fracture dislocations obtained statistically better scores than patients with pure dislocations.

Résumé Nous avons revu 42 malades (âge moyen 37.7±14.2 années) ayant présenté une fracture-luxation du Lisfranc traitée par vissage percutané. Le suivi moyen de était 58.4±17.3 mois. Le but était d'étudier les différences entre les luxations réduites anatomiquement et celles qui ne l'étaient pas parfaitement. Le score AOFAS moyen pour tous les malades était 81.0±13.5. Il n'y avait pas de différences notables dans les scores entre malades avec parfaite réduction anatomique et malades avec réduction anatomique approximative. Les patients avec fracture-luxation ont cependant obtenu statistiquement de meilleurs scores que les patients avec luxation pure.

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Introduction

Fracture dislocations or pure dislocations of the tarsometatarsal joint account for 0.2% of all fractures [7]. The initial injury is frequently missed or misdiagnosed, especially when multitrauma is involved. Grossens and de Stoop [9] estimated that almost 20% of Lisfranc fracture dislocations are not recognized, and these findings are also similar to those reported by others [4, 15]. Males are two to ten times as likely to sustain tarsometatarsal fracture dislocations, at an average age of the mid-30s [4]. These injuries may be caused by both direct and indirect forces and range widely from high-energy trauma with severe disorganization of the midfoot to subtle subluxations due to simple sprains [15].

Effective treatment requires anatomic reduction and secure fixation, which does not guarantee an uncomplicated course; however, it does improve functional results. Although Aitken and Poulson [2], and more recently Brunet and Wiley [6], supported the view that functional outcome is not affected by the accuracy of reduction, current reports show that anatomic reduction and stable fixation are main factors, which will influence the outcome favorably [4, 7, 13, 15].

With any degree of displacement there is no place for conservative management: it is well-documented that closed reduction and cast immobilization are insufficient and that, rather, closed reduction and percutaneous pin or screw fixation or open reduction and internal fixation is recommended [7, 15, 16, 19]. Although most authors agree that anatomic reduction and stable fixation is essential, there continues to be some controversy as to how this is best achieved. Some advocate closed reduction and percutaneous fixation (CRPF) whenever possible [5, 9, 10, 11, 15, 21], while others perform open reduction and internal fixation (ORIF) in all cases [3, 4, 7, 13, 18, 20]. The purpose of the present study was to analyze results of closed reduction and percutaneous screw fixation in injuries of the tarsometatarsal joint.

Materials and methods

We performed a multicenter retrospective study of patients with tarsometatarsal fracture dislocations treated by closed reduction and percutaneous fixation between 1994 and 1999. Indications for CRPF were closed injuries reducible by manipulative maneuvers, regardless of the magnitude of the dislocation and deformity. There were 49 patients. In seven patients a closed reduction could not be performed so as to fulfill the radiographic parameters described later. These patients were excluded from the study.

Several radiographic parameters were used to assess alignment preoperatively, intraoperatively, and at the follow-up evaluation.

In the normal foot, the medial edge of the second metatarsal should parallel the medial border of the second cuneiform in both the anteroposterior and the oblique projections. Likewise, in the oblique view, the medial border of the fourth metatarsal should align with the medial border of the cuboid, and the lateral border of the third metatarsal should be linear with the lateral border of the lateral cuneiform. On the lateral X-ray, a metatarsal should never lie more dorsal than its respective tarsal bone. On the anterior-posterior and oblique views, a widening of the first intermetatarsal space was considered a sign of joint subluxation. The talometatarsal angle also was used to evaluate sagittal deformity. The reduction was considered anatomical if the above-mentioned relationships were intact, nearly anatomical if they were within 2 mm, and nonanatomical if they were off by greater than 2 mm (or more than 15° of persistent talo-first metatarsal angulation) [11, 13, 15, 16] (Fig. 1).

Injuries were classified as described by Myerson et al. [16]. The dislocations were treated as soon as possible after injury under spinal or general anesthesia. Attempts of closed reduction were performed by gentle manipulation and traction, checking fluoroscopically residual tarsometatarsal displacement, or persistent talo-first metatarsal angulation. Once reduction was achieved, percutaneous Kirschner guide wires were introduced, and stab wounds were made over the wires to insert 4 mm cannulated cancellous screws (Figs. 2a, b, c, d and 3a, b). (See Table 1 for clinical details.)

At 6 weeks, weightbearing was commenced in a removable articulated walking boot, and all internal fixation devices were removed before full activities were begun, usually after 4–6 months. The mean length of follow-up was 58.4±17.3 months. Patients were asked to return to the office for completion of a questionnaire, clinical examination, radiographs, and – in some cases – follow-up MR in order to study the ligamentous injuries.

Follow-up X-ray analysis (minimum 24, maximum 84 months) and clinical examination of patients was performed by foot surgeons not involved in any way in the operative procedures (A.U.M.S. and M.S.); on the basis of the radiographic parameters described, they decided if the reductions were anatomic or nearly anatomic.

The American Orthopaedic Foot and Ankle Society (AOFAS) midfoot score established by Kitaoka et al. [12] was used for the clinical and subjective evaluations. The Student's *t*-test was used to compare the AOFAS foot score between patient subgroups (Table 2). Differences in *P* values <0.05 were considered statistically significant.

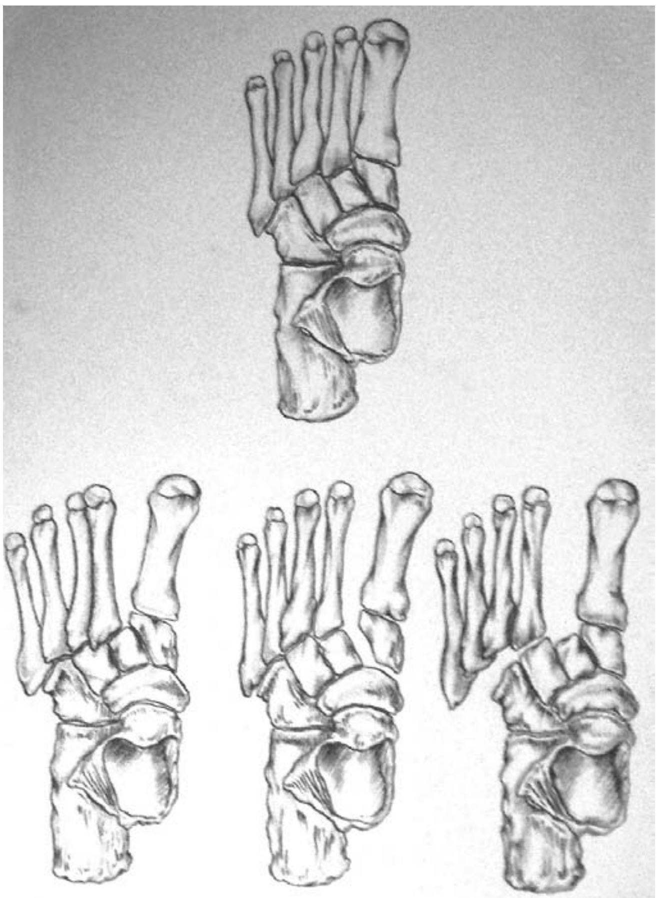

Fig. 1 Schematic representation of different types of tarso-metatarsal dislocations

Results

The average AOFAS midfoot score was 81.0 (±13.5 SD) points. No statistically significant differences could be detected when outcome scores of patients with anatomical reduction were compared with outcome scores of patients with nearly anatomical reduction, in both the combined fracture dislocation and pure dislocation subgroups (Fig. 4) (Table 2).

We detected a statistically significant difference in outcome scores between patients with purely ligamentous injuries and patients with combined ligamentous and osseous injuries, with the latter having a better AOFAS score (Table 2).

Discussion

Anatomical reduction and stable internal fixation has become the standard principle governing treatment of tarsometatarsal fracture dislocations [7, 15, 16, 19]. There is some controversy as to how this is best achieved. There are proponents of ORIF in all cases [3, 4, 7, 13, 18, 20], while others advocate CRPF whenever possible [5, 8, 9, 10, 11, 14, 15, 21].

Anatomic reduction, regardless of the extent of initial displacement, can often be achieved by closed means, and percutaneous internal fixation with screws or K-wires is recommended to ensure the maintenance of reduction until capsular or bone healing (or both) occurs. However, sometimes several factors may lead to inadequate closed reduction, thereby necessitating ORIF, as, for example, entrapment of bony fragments or soft tissues in the joint, or the combination of the fracture dislocation with significant associated impaction fracture of the cuboid (nutcracker fracture) [4, 15, 16].

Fig. 2 a,b Type A fracture dislocation of the Lisfranc joint: dorsoplantar and lateral views. **c,d** CRPF by two 4 mm cannulated cancellous screws placed from the base of the metatarsal shaft into the corresponding cuneiform and a K-wire across the fifth tarsometatarsal joint

We treat all closed Lisfranc injuries with closed reduction and screw fixation whenever possible. Like other authors [1, 11, 20], we believe that the guidelines of Myerson et al. [16], of greater than 2 mm of residual tarsometatarsal displacement or more than 15° of persistent talo-first metatarsal angulation after attempts of closed reduction, provide a good basis to pursue an open procedure.

Reduction is considered anatomical if the radiographic parameters are intact, nearly anatomical if they are within 2 mm, and nonanatomical if they are off by greater than 2 mm [13, 15]. Recent clinical studies comparing the outcome of the anatomical, nearly anatomical, and nonanatomical reduction subgroups showed that only patients with nonanatomical reduction had a significantly higher prevalence of posttraumatic osteoarthritis [13]. In our study, no statistically significant differences could be detected when outcome scores of patients with anatomical reduction were compared with outcome scores of patients with nearly anatomical reduction, in both the combined fracture dislocation and pure dislocation sub-

Fig. 3 Pure dislocation of the Lisfranc joint: in this particular case, additional screws were used in order to obtain a more rigid fixation because of extreme joint instability

groups. The conclusion is that even a nearly anatomical reduction is considered acceptable and predictive of a satisfactory outcome [1, 20].

On the basis of our results and on a review of the literature, we support the fact that the outcome is correlated with the accuracy of reduction and not with the surgical technique (open or closed method), while results of closed reduction and cast immobilization are disappointing [5, 9, 15, 16, 22, 23]. Richter et al. [17], comparing open and closed treatment of fractures and fracture dislocations of the midfoot, found no significant difference in the AOFAS score for age (<35 years and >35 years), gender, cause of the injury (motor vehicle accidents or other), and method of treatment (ORIF or CRPF).

Kuo et al. [13] found that patients with purely ligamentous injury had a trend toward a significantly higher prevalence of posttraumatic osteoarthritis compared with patients with combined ligamentous and osseous injuries. Our study supports this observation, as patients with pure dislocations had significantly worse average AOFAS outcome scores when compared with patients with combined fracture dislocations. This suggests that the injury rather than the treatment has more influence on the outcome: it seems that the ligament-bone interface cannot heal with sufficient strength to regain stable long-term function [13].

The trends lead to several considerations. First, the overall outcome is correlated with the accuracy of reduction (anatomical or nearly anatomical) and not with the surgical technique (open or closed method). Second, the use of screws for medial column stabilization seems to be the most secure method of fixation. Third, in cases of pure dislocations, anatomical or nearly anatomical reduction may be less predictive of a good outcome than in cases of combined fracture dislocations. Fourth, diagno-

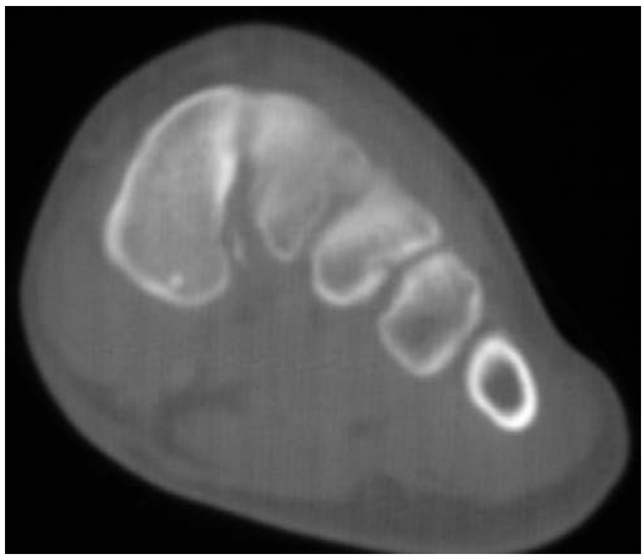

Fig. 4 Patients with only a fleck sign (avulsion fracture of the Lisfranc ligament) were considered to have purely ligamentous lesions

Table 1 Clinical features. Mean American Orthopaedic Foot and Ankle Society (*AOFAS*) score (all patients): 81.0±13.5, mean age (years): 37.7±14.2, mean follow-up (*FU*) (months): 58.4±17.3

Patients	Age	Gender	Lesion	Reduction	Classification	FU	AOFAS
1	33	Male	Fracture dislocation	Anatomical	Type A	69	85
2	45	Male	Fracture dislocation	Nearly Anatomical	Type B	70	78
3	57	Female	Pure dislocation	Anatomical	Type B	26	65
4	22	Male	Fracture dislocation	Anatomical	Type A	56	73
5	17	Male	Fracture dislocation	Anatomical	Type C	49	90
6	62	Female	Fracture dislocation	Nearly Anatomical	Type B	72	97
7	47	Female	Pure dislocation	Nearly Anatomical	Type B	66	90
8	70	Male	Pure dislocation	Anatomical	Type A	59	70
9	35	Male	Fracture dislocation	Anatomical	Type A	24	58
10	27	Female	Fracture dislocation	Anatomical	Type C	29	97
11	49	Male	Fracture dislocation	Nearly Anatomical	Type B	76	78
12	37	Female	Fracture dislocation	Nearly Anatomical	Type A	62	90
13	32	Male	Pure dislocation	Anatomical	Type C	77	58
14	20	Male	Fracture dislocation	Anatomical	Type B	37	95
15	33	Female	Pure dislocation	Nearly Anatomical	Type C	71	65
16	51	Male	Fracture dislocation	Anatomical	Type A	69	100
17	37	Male	Pure dislocation	Anatomical	Type B	81	80
18	45	Male	Fracture dislocation	Anatomical	Type C	43	97
19	42	Male	Fracture dislocation	Anatomical	Type A	51	83
20	23	Female	Fracture dislocation	Nearly Anatomical	Type B	58	80
21	36	Male	Pure dislocation	Anatomical	Type B	82	78
22	65	Female	Fracture dislocation	Nearly Anatomical	Type C	42	95
23	30	Male	Fracture dislocation	Nearly Anatomical	Type B	79	78
24	43	Female	Fracture dislocation	Anatomical	Type B	58	93
25	57	Male	Pure dislocation	Anatomical	Type A	50	82
26	20	Male	Fracture dislocation	Nearly Anatomical	Type A	27	73
27	19	Male	Pure dislocation	Nearly Anatomical	Type B	65	61
28	24	Male	Fracture dislocation	Anatomical	Type C	84	100
29	21	Female	Fracture dislocation	Nearly Anatomical	Type B	83	73
30	32	Female	Fracture dislocation	Anatomical	Type A	75	90
31	49	Male	Pure dislocation	Anatomical	Type B	52	77
32	22	Male	Fracture dislocation	Anatomical	Type C	30	90
33	46	Female	Pure dislocation	Nearly Anatomical	Type B	41	47
34	69	Male	Fracture dislocation	Anatomical	Type B	61	73
35	24	Male	Fracture dislocation	Anatomical	Type A	75	90
36	29	Male	Fracture dislocation	Nearly Anatomical	Type A	55	100
37	36	Female	Fracture dislocation	Anatomical	Type C	63	97
38	42	Male	Pure dislocation	Anatomical	Type B	38	58
39	32	Male	Fracture dislocation	Anatomical	Type C	80	73
40	25	Male	Fracture dislocation	Nearly Anatomical	Type A	68	95
41	48	Female	Fracture dislocation	Nearly Anatomical	Type C	57	78
42	31	Male	Fracture dislocation	Nearly Anatomical	Type A	46	73

Table 2 Comparison of American Orthopaedic Foot and Ankle Society (*AOFAS*) scores within subgroups. *FR-D* combined fracture dislocation, *P-D* pure dislocation, *A-R* anatomical reduction, *NA-R* nearly anatomical reduction

Subgroup	No. patients	Mean AOFAS	*P* Value
FR-D	30	85.7±11.0	*P*=0.000
P-D	12	69.2±12.4	
FR-D/A-R	17	82.7±11.7	*P*=0.384
FR-D/NA-R	13	83.6±10.1	
P-D/A-R	8	65.2±23.0	*P*=0.971
P-D/NA-R	4	65.7±17.9	

sis and treatment of Lisfranc fracture dislocations is still a problem in trauma care and can influence the functional outcome of the entire foot in the mid- and long-term follow-up, resulting in a high degree of potential residual impairment.

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