Results of isolated Lisfranc injuries and the effect of compensation claims

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The results of treatment of Lisfranc injuries are often unsatisfactory. This retrospective study investigated 46 patients with isolated Lisfranc injuries at a minimum of two years after surgery. Thirteen patients had a poor outcome and had to change employment, or were unable to find work as a result of this injury. The presence of a compensation claim ($p = 0.02$) and a delay in diagnosis of more than six months were associated with a poor outcome ($p = 0.01$). There was no association between poor functional outcome and age, gender, mechanism of injury or previous occupation. This study may have medico-legal implications on reporting the prognosis for such injuries, and highlights the importance of prompt diagnosis and treatment.

Lisfranc injuries are dislocations and fracture dislocations through the tarsometatarsal joints. The outcome for displaced injuries is improved following anatomical open reduction and internal fixation (ORIF), but up to 20% may be misdiagnosed or overlooked.¹⁻⁴ Several studies report a high incidence of unsatisfactory results following treatment.^{1,2,5,6} Most reports, however, include patients with associated injuries which may influence the outcome; of 72 patients reported by Myerson et al,² 81% were polytrauma patients and 32% had concomitant ipsilateral foot and ankle fractures. Therefore, it is difficult to interpret the true results of isolated Lisfranc injuries.

Workers' compensation claims have been shown to influence the results of treatment for other orthopaedic injuries.⁷ Although no significant correlation has been demonstrated between the clinical outcome and age, gender or injury pattern/classification for Lisfranc injuries, no reports specifically examine the influence of workers' compensation on the ability of individuals to return to work.² This may have implications on medico-legal reporting for the prognosis of such injuries and back-to-work schemes employed by companies.

The aim of this study was to investigate the long-term outcome of isolated, displaced Lisfranc injuries requiring operative intervention and to identify whether the results of treatment are influenced by compensation claims.

Patients and Methods

For this retrospective study the clinical notes of all patients who underwent operative intervention for Lisfranc injuries between January 1995 and January 2000 were reviewed. The senior author (TSS) performed all the operations. Patients with concomitant injuries were excluded from further investigation so that the outcome of isolated Lisfranc injuries could be assessed.

The presence of a compensation claim arising as a direct result of the injury was recorded and, where appropriate, workers' compensation (Workcover) records were examined to identify the financial implications of such injuries.

All patients were contacted to record their employment status. The functional outcome of surgery was recorded on an ordinal scale: 1, returned to normal employment; 2, returned to previous employment but with minor modifications; 3, had to change employment; and 4, unable to perform any useful work purely as a result of the injury. The outcome was considered to be good if the functional result was recorded as 1 or 2 and poor if the result was 3 or 4.

Initially, tests of association were performed using chi-squared tests with Bonferroni's correction for multiple testing being applied. Where small frequencies were encountered, condensing of data was necessary and Fisher's exact test was performed. The correlation of age with outcome was assessed using Kendall's tau, which is a non-

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Table I. Frequencies of good and poor outcome (with percentages) for each variable, p values obtained with Fisher's exact test and significance when corrected using Bonferroni

Explanatory variables		Functional outcome		p value
		Good (%)	Poor (%)	
Gender	Male	21 (63.6)	12 (36.4)	0.051
	Female	12 (92.3)	1 (7.7)	
Compensation claim	Yes	13 (54.2)	11 (45.8)	0.006*
	No	20 (90.1)	2 (9.1)	
Delay in treatment	≤ 3 months's delay	22 (88.0)	3 (12.0)	0.009*
	3 to 6 months	2 (66.7)	2 (33.3)	
	> 6 months	9 (52.9)	8 (47.1)	
Mechanism of injury	Twist (low energy)	22 (88.0)	3 (12.0)	0.009*
	Crush (high energy)	5 (50.0)	5 (50.0)	
	Fall (high energy)	3 (42.9)	4 (57.1)	
	MVA (high energy)	3 (75.0)	1 (25.0)	
Occupation	Manual	10 (62.5)	6 (37.5)	0.248
	Standing/walking	10 (62.5)	6 (37.5)	
	Sedentary	13 (92.9)	1 (7.1)	

* significant at 5%

parametric measure of association for ordinal variables (as outcome is ordinal).

However, due to the condensing of data that this type of testing necessitates and hence the loss of information, it is possible that spurious results may ensue. As a result, ordinal regression analysis was then performed to identify which factors influenced the outcome. Ordinal regression is an extension of logistic regression which allows for an ordinal dependent variable rather than a dichotomous one.⁸ Due to the number of subjects in the sample, it is advisable to include a maximum of five explanatory variables in the regression model with the introduction of dummy variables for nominal variables. The results from the association tests were therefore used in order to identify which explanatory variables were most likely to be influential in the model. Further analysis was then performed on this subject of variables. Data were collated using Microsoft Excel, and statistical analysis was performed using the SPSS statistical package (SPSS Inc, Chicago, Illinois).

Results

Fifty-four patients were identified from records. Since eight patients could not be contacted and were excluded from further analysis, 46 patients were studied. All characteristics and associated outcomes are presented in Table I with p values obtained when each characteristic was tested for association with outcome (good/poor) using Fisher's exact test. The critical value for significance at 5% using Bonferroni's correction in this instance is $p = 0.01$.

Of the 46 patients studied, at the time 24 were pursuing or had pursued medico-legal claims as a direct result of their injuries (16 Workcover and eight civil claims). This was significant at the 5% level when testing for association using Fisher's exact test ($p < 0.01$) as described in Table I.

The minimum duration of follow-up was 24 months after the date of final surgery (24 to 48). There were 33 men and 13 women with a mean age of 36.3 years (17 to 60).

Age was not correlated with outcome (Kendall's tau = 0.094). The cause of injury was a low-energy twist in 25 patients. High-energy injuries included a crush injury in ten patients, a fall of greater than 2 m in seven and a motor vehicle accident (MVA) in four. Due to low expected frequencies, this factor was compared as high- *versus* low-energy injuries which yielded a significant result at the 5% level after correction for multiple testing ($p = 0.01$). These characteristics are shown in Table I.

The time interval from injury to surgery in 25 patients was less than three months. Four patients were seen at three to six months and 17 were treated more than six months following injury. Treatment was by ORIF or fusion using 4.5 mm cannulated screws. Those patients seen within three months of injury underwent ORIF followed by six weeks in a cast and subsequent removal of metal at three to four months. When surgery was delayed longer than six months from injury, all patients underwent fusion. Two of the four patients seen between three and six months from injury underwent fusion. Three patients in whom ORIF was initially performed subsequently required fusion because of secondary osteoarthritis. Two underwent ORIF within one month of injury and the third at three months. Delay of operation was tested for association, as delay of less than three months *versus* delay of greater than three months due to low expected frequencies ($p = 0.01$), which was significant at the 5% level as shown in Table I.

Occupation at the time of injury included 16 manual workers (builders/labourers), 16 patients whose jobs included walking/long periods of standing (teachers/nurses) and 14 sedentary workers (office/desk-based). Again, due to low expected frequencies, these were condensed to manual *versus* walking, standing and sedentary jobs. There was no significant association between occupation and outcome as seen in Table I ($p = 0.248$).

Using the results from the above analyses to identify which variables are most likely to be influential in the

Table II. Ordinal regression analysis with outcome (1, 2, 3 or 4) as dependent variable and compensation claim, delay in treatment (dummy variable reference is delay less than three months) and mechanism of injury (dummy reference is twist) as independent variables

Variable	Estimate	Standard error	p value	95% confidence interval
Compensation claim	-2.205	0.967	0.023*	-4.101 to -0.309
Delay 3 to 6 months	-2.130	1.140	0.062	-4.365 to 0.106
Delay > 6 months	-2.029	0.792	0.010*	-3.581 to -0.477
Crush injury	-0.691	0.983	0.482	-2.618 to 1.237
Fall or MVA injury	-1.073	0.909	0.238	-2.855 to 0.709

* significant at 5%

model (with 46 cases, a maximum of five explanatory variables should be included in the regression model), ordinal regression was performed to identify factors which may be influential in the model. Dummy variables were created where the data type dictated. In order to keep the number of explanatory variables to five, in the occupation category, falls and MVA were combined as these had the lowest frequencies. Subsequent testing indicated that this did not alter the final model.

The results from this analysis are shown in Table II. The only factors which significantly influenced outcome were the presence of a compensation claim ($p = 0.023$) and delay in treatment of more than six months ($p = 0.010$ for more than six months and $p = 0.062$ for between three and six months). Supplementary analysis indicated that there was no significant difference between delay in operation of more than six months and delay of between three and six months ($p = 0.93$), since there are only four subjects in this group. Hence the significant factor is a delay in treatment of greater than six months. Also, changing the dummy refer-

ence for injury type did not significantly change the model (i.e. all types of injury are not significant).

Discussion

Although pure ligamentous injuries carry a poorer prognosis than fracture-dislocations, it has previously been shown that classifications do not correlate with outcome.^{1,2,6} We selected only displaced injuries requiring operation and did not attempt to classify them. Symptoms following Lisfranc joint injuries may improve for an average of 1.3 years,⁵ and therefore we also ensured a minimum follow-up of two years before assessing the ability to return to work.

Our study has shown that those patients who are pursuing compensation claims following surgery for displaced Lisfranc injuries have a poor prognosis, independent of any other factors. This should be borne in mind when predicting the outcome following operation for Lisfranc fracture/dislocations in medico-legal reporting. This finding also has important implications for Workcover or companies responsible for schemes aimed at returning such patients to full employment, as the average Workcover payment was more than \$50,000 (approximately £25,000).

Myerson et al² recommended open reduction for more than 2 mm displacement or a tarsometatarsal angle greater than 15°. Lisfranc injuries are notoriously difficult to diagnose and up to 20% are missed at initial presentation thus delaying treatment.⁴ Delayed diagnosis is a particular problem in the polytrauma patient where the injury may be overlooked.² Weight-bearing views, when the patient is more comfortable, or MR/CT scanning, have all been shown to improve diagnosis (Figs 1 to 3).⁹⁻¹³ We have demonstrated that a delay in diagnosis may have a detrimental

Fig. 1a

Fig. 1b

Anteroposterior (AP) and oblique non-weight-bearing radiographs of the left foot of a 38-year-old man, who suffered a hyperdorsiflexion injury at work. These were interpreted as normal by the initial treating doctor. He was advised that he had a 'sprained foot' and was treated by restricted weight-bearing. These films are abnormal, since there is an increased gap between the base of the first and second metatarsal.

Fig. 2a

Fig. 2b

AP weight-bearing radiographs of both feet in the same patient as Figure 1 taken ten weeks later because of ongoing pain and swelling of the foot showing displacement of the first, second and third tarsometatarsal joints and illustrating the need for weight-bearing radiographs.

Fig. 3

AP weight-bearing post-operative radiograph of the left foot of the same patient showing reduction of the dislocation and internal fixation of the first, second and third tarsometatarsal joints.

effect upon the eventual clinical outcome and this highlights the importance of maintaining a high index of suspicion when the mechanism of injury raises the possibility of a Lisfranc fracture/dislocation.

This group of 46 patients has a long follow-up of a rare injury. We have shown that delay in treatment or a concomitant compensation claim are both associated with a poor prognosis. Age, gender, mechanism of injury or occupation prior to injury do not appear to affect outcome.

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