Patient-reported functional outcomes and health-related quality of life following fractures of the talus

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ABSTRACT

INTRODUCTION The primary aim of this study was to investigate patient-reported outcomes following talar fractures. Secondary aims were to investigate health-related quality of life and to determine whether it is influenced by functional outcome.

MATERIALS AND METHODS This retrospective study identified 56 talar fractures over eight years. Patients were contacted by post and the Olerud and Molander score (OMS), Manchester–Oxford Foot and Ankle scores (MOXFQ) and Euroqol-5D-3L collected.

RESULTS The mean age was 35.2 years (range 13–78 years). There were four cases (7.1%) of avascular necrosis and one (1.8%) non-union occurred. Data from patient-reported outcome measures were available for 42 patients (75.0%) with a median follow-up of 67.1 months (range 23.2–111.8 months). Mean OMS was 60.0 (standard deviation $\pm$ 29.51) and median MOXFQ was 30.33 (interquartile range 47.13). Median Euroqol-5D-3L index was 0.74 (interquartile range 0.213) and median Euroqol-5D-3L visual analogue score was 80 (interquartile range 21). Older age, open fractures, multiple injuries and subsequent avascular necrosis were associated with worse patient-reported outcomes ($P < 0.05$), with older age, avascular necrosis and open fractures found to be independent predictors of poor OMS, and avascular necrosis and open fractures independently predicting MOXFQ score on regression analysis ($P < 0.05$). Poor self-reported function, measured by OMS and MOXFQ, correlated with worse health-related quality of life as measured by the Euroqol-5D-3L index (OMS: $r = 0.764$, $P < 0.001$; MOXFQ: $r = 0.824$, $P < 0.001$) and visual analogue score (OMS: $r = 0.450$, $P = 0.003$; MOXFQ: $r = 0.559$, $P < 0.001$).

CONCLUSIONS Older age, avascular necrosis and open fractures predict poorer functional outcomes following talar fractures. Patients with worse limb-specific functional outcomes are more likely to have a worse perception of health-related quality of life.

KEYWORDS

Talus–Talar fractures–Avascular necrosis–Ankle arthritis

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Introduction

Talar fractures account for 0.5% of fractures in adults,¹ and can be associated with significant morbidity including avascular necrosis, post-traumatic arthritis, wound complications, and non-union.^{2–5} Previous studies have focused primarily on the incidence of complications after talar fractures.^{3–6} Functional outcomes following these injuries have been reported but have been restricted to a specific treatment modality^{7–9} or fracture configuration.^{10–11}

It is increasingly recognised that patient-reported outcome measures and health-related quality of life are key indicators of outcome following elective procedures and interventions for trauma,¹² as they reflect patients' perspective of their injuries and may differ from the surgeons' perceptions.¹³ Although multiple clinical studies in the field of trauma and orthopaedics now focus on patient-

reported outcome measures and health-related quality of life,^{14–16} in the context of talar fractures there is little information in this regard, with only one previous study investigating the effects of long-term complications on health-related quality of life;¹⁷ this study was restricted to a group of surgically treated patients.

The primary aim of this study was to report foot and ankle-specific patient-reported outcome measures following fractures of the talus, as measured by the Olerud and Molander score (OMS),¹⁸ and to determine which factors influence outcome. Secondary aims were to report the Manchester–Oxford Foot Questionnaire (MOXFQ) PROM for these patients,¹⁹ and to assess the relationship between self-reported foot and ankle function and patients' overall health-related quality of life following talar fractures.

Methods

All patients aged 13 years and over presenting to acute trauma services between 2008 and 2015 with a fracture of the talus were identified retrospectively through a computer search of electronic patient records. All health records are electronically recorded, with a specific coded diagnosis that allowed identification of patients with talar fractures. Exclusion criteria were isolated osteochondral lesions and fractures occurring in children under the age of 13 years. Fractures were classified according to Snenpen and Hawkins classification systems for body and neck fractures respectively.^{20–22} Patient demographics, comorbidities and mechanism of injury were recorded from patient records. Road traffic collisions, crush injuries and falls or jumps from a height of greater than two metres were considered high-energy injuries while all other mechanisms were considered low energy. Social deprivation status was determined using the Scottish Index of Multiple Deprivation, a government resource that considers employment, income, crime, housing, health, education and access to services to classify socioeconomic deprivation nationwide according to postcode.²³ Management and complications were also recorded.

Follow up

Patient-reported outcomes were collected by postal questionnaire. The OMS, MOXFQ and EuroQol-5D-3L were collected.²⁴ The OMS consists of nine domains related to pain, other symptoms and physical impairment. A summative score is calculated where 100 is the best possible score (least symptomatic) and 0 is the worst possible score (most symptomatic). The OMS has been shown to have good reliability and internal consistency.²⁵ The MOXFQ consists of 16 questions answered on a Likert scale, where each item is scored from 0 to 4 and 4 denotes 'most severe' symptoms. Scores for each question are then summated to assess impact over different domains. The scores are converted to a number from 0 to 100, where 100 represents the most severe symptoms. The MOXFQ and its derived index have been shown to have good reliability.²⁶ The EuroQol general health questionnaire evaluates five domains (-5D): mobility, self-care, usual activities, pain/discomfort, and anxiety/depression.^{24,27} Patient responses on a three-point Likert scale are then used to calculate a time trade-off (TTO) index which scored from 0 (a death state) to +1 (a perfect health state), where negative scores represent a state worse than death.²⁷ The EuroQol-5D has been extensively validated for use in the elective²⁸ and trauma^{29,30} settings and is recommended by the NHS Outcomes Framework for England for assessment of patients following limb trauma.³¹

Statistical analysis

Statistical analysis was performed using the Statistical Package for Social Sciences version 20. The primary outcome measure (OMS) was found to be normally distributed on Kolmogorov–Smirnov testing and parametric tests were therefore used to determine the effect of predictors on this

outcome. Two-tailed Student *t*-tests were used to assess variation in mean OMS across groups. Comparison of OMS with continuous and ordinal variables was undertaken using Spearman's rank testing. A linear regression model was constructed using 'enter' methodology to determine the independent effect of multiple variables on OMS after talar fracture. Potential predictor variables, which were identified on univariate and bivariate analysis with a *P*-value of less than or equal to 0.1 were included in the multiple regression model. Return to work was not included in the regression analysis as it was thought that this could be dependent on foot and ankle function rather than predictive of it. The lax *P*-value of 0.1 was used because variables that just fail to reach statistical significance with use of a lower cut-off may achieve significance when adjusted for other variables in the multivariate analysis. MOXFQ and EuroQol-5D scores were found to be non-parametric and the independent samples Mann–Whitney *U*-test and Spearman's rank test were used to determine predictors. A *P*-value of less than 0.05 was considered significant.

Results

Fifty-six talar fractures were identified. The mean age at presentation was 35.2 years (range 13–78 years). There were 16 (28.5%) women and 40 (71.5%) men. Fifteen patients (26.8%) had a mental health comorbidity and six (10.7%) sustained their injury while attempting suicide. A total of 36 fractures (61.2%) resulted from a high-energy mechanism of injury, and 29 (51.8%) fractures occurred with one or more concurrent orthopaedic injuries. There were 28 (50.0%) talar body and 28 (50.0%) talar neck fractures (Table 1). The most common fracture observed was a Hawkins type II fracture which occurred in 14 patients

Table 1 Fracture patterns.

Fracture type	Patients	
	(n)	(%)
Hawkins:		
I	9	16.1
II	14	25.0
III	5	8.9
IV	0	0
Snenpen:		
I	0	0
II	11	19.6
III	5	8.9
IV	4	7.1
V	6	10.7
Medial process	2	3.6

Table 2 Univariate/bivariate analysis to identify potential predictors of Olerud–Molander score.

	Variable; Mean; SD	Variable; Mean; 95% CI Mean; SD	P-value ^a
Gender	Male; 52.92; ± 25.8	Female; 62.83; ± 30.8	0.331 ^b
Age at injury	Spearman's correlation coefficient –0.357. Negative correlation		0.02^c
Hawkins classification	Spearman's correlation coefficient –0.154. Negative correlation		0.48 ^c
Social deprivation status	Spearman's correlation coefficient –0.096. Negative correlation.		0.567 ^c
Smoking status	Yes; 47.00; ± 37.28	No; 64.06 ± 26.01	0.11 ^b
Mental health comorbidity	Yes; 60.83; ± 38.8	No; 59.86; ± 28.75	0.94 ^b
Open/closed	Open; 18.33; ± 12.58	Closed; 63.21; ± 28.0	0.009^b
Associated injuries	Yes; 43.33; 30.44	No; 72.50; 22.07	0.001^b
Operatively managed	Yes; 53.33; 28.62	No; 68.89; 29.08	0.091 ^b
Presence of AVN	Yes; 21.67; 16.07	No; 62.95; 28.30	< 0.018^b
Presence of non-union	Yes; 61.0; 35.36	No; 40.0; 29.36	0.332 ^b

AVN, avascular necrosis; CI, confidence interval; SD, standard deviation.
^a Figures in bold signify a significant finding.
^b Two-tailed Student *t*-test.
^c Spearman's correlation

(23.5%), followed by a Sneppen type II shear fracture of the body in 11 patients (19.6%).

Some 30 patients (53.6%) were treated operatively and 26 (46.4%) were treated non-operatively. The most common treatment modality was fracture reduction with cannulated interfragmentary screw fixation in either an anteroposterior or posteroanterior configuration. This construct was used in 22 cases (73%).

There were four (7.1%) confirmed cases of avascular necrosis and one (1.8%) case of non-union. At the time of writing, seven patients (12.5%) had undergone or were awaiting a planned secondary fusion for post-traumatic osteoarthritis. Patient-reported outcome data were available for 42 (75%) patients with a median follow-up of 67.1 months post-injury (range 25.2–111.8 months). The average OMS was 60.0 (standard deviation, SD, ± 29.51; 95% confidence interval, CI, for mean score 50.8–69.2). Median MOXFQ was 30.33 (interquartile range, IQR, 47.13). Median EuroQol-5D index was 0.74 (IQR 0.213) and EuroQol-5D health visual analogue score 80 (IQR 21). Increased age at time of injury, open fractures, multiple injuries, subsequent avascular necrosis and lack of return to work were associated with worse OMS ($P < 0.05$) on univariate or bivariate analysis (Table 2).

Increased age, avascular necrosis and open fractures were found to be independent predictors of poor OMS on linear regression analysis, after adjusting for confounding variables (Table 3). Increasing age, multiple and open injuries were also found to be predictive of patient reported MOXFQ score after talar fracture (Tables 4 and 5).

Median EuroQol-5D-3L TTO index was 0.735 (IQR 0.213) and the median health status as indicated on the

visual analogue scale was 80 (IQR 21). OMS ($r = 0.764$, $P < 0.001$; Figure 1a) and MOXFQ ($r = 0.824$, $P < 0.001$, Figure 2a) scores correlated strongly with EuroQol-5D TTO index scores. They also correlated moderately with EuroQol-5D health today visual analogue scores (OMS: $r = 0.450$, $P = 0.003$, Figure 1b; MOXFQ: $r = 0.559$, $P < 0.001$, Figure 2b).

Discussion

This study describes patient-reported outcomes after fractures of the talus. Avascular necrosis, increased age at the time of injury and open fractures were shown to be independent negative predictors of patient-reported functional outcome as measured by OMS after adjusting for confounding variables. Foot and ankle-specific outcome measures (OMS and MOXFQ) correlated directly with health-related quality of life after talar fractures.

Table 3 Linear regression analysis to identify independent predictors of Olerud–Molander score.

Variable	B-value (95% confidence interval)	P-value
Age	–0.546 (–0.999 to –0.093)	0.02
Open injury	–36.779 (–64.773 to –8.786)	0.01
Associated injuries	–13.018 (–28.960 to 2.796)	0.1
Operative management	–11.208 (–25.242 to 2.826)	0.1
Avascular necrosis	–37.259 (–65.604 to –8.913)	0.01

Table 4 Univariate/bivariate analysis to identify potential predictors of MOXFQ.

	Variable ; median; IQR	Variable ; median; IQR	P-value ^a	Test
Gender	Male; 33.61; 56.97	Female; 22.95; 45.08	0.314	ISMWU
Smoking status	Yes; 42.62; 82.79	No; 27.05; 43.44	0.236	ISMWU
Mental health comorbidity	Yes; 17.21; 63.52	No; 31.15; 44.26	0.661	ISMWU
Open/closed	Open; 60.66; No IQR as numbers too small)	Closed; 22.95; 42.62	0.018	ISMWU
Associated injuries	Yes; 45.90; 68.85	No; 19.67; 35.25	0.014	ISMWU
Operatively managed	Yes; 33.61; 51.64	No; 16.39; 35.25	0.094	ISMWU
Hawkins sign	Yes; 3.28; 22.95	No; 37.70; 56.15	0.368	ISMWU
Avascular necrosis	Yes; 86.89; No IQR as numbers too small	No; 29.17; 42.62	0.100	ISMWU
Non-union	Yes; 54.91; NO IQR as numbers too small	No; 30.33; 45.90	0.455	ISMWU
Return to work	Returned; 22.95; 42.62	55.74; 77.05	0.086	ISMWU

IQR, interquartile range; ISMWU, Independent samples Mann-Whitney U test.

^a Figures in bold signify a significant finding.**Table 5** Linear regression analysis to identify independent predictors of Manchester–Oxford Foot and Ankle scores.

Variable	B-value (95% CI)	P-value
Age	.395 (–.119 to .910)	.128
Open fracture	35.118 (3.332 to 66.904)	.031
Associated injuries	12.427 (–5.604 to 30.457)	.171
Operative management	12.571 (–3.364 to 28.506)	.118
Avascular necrosis	34.595 (2.309 to 66.781)	.036

Talar fractures are rare and, consequently, most previous studies of these injuries and their sequelae are small.¹ Avascular necrosis has been reported to occur in 5.7–65% of talar fractures depending on fracture pattern.^{52–53} Previous studies have shown avascular necrosis to predict poorer functional outcomes.^{3,7} This is confirmed by our findings, which, despite the relatively low incidence of avascular necrosis observed in this study, demonstrated a relationship with poorer patient reported outcomes which was significant even after adjusting for confounding variables. The presence of avascular necrosis was associated with a mean OMS reduction of more than 35 points (Tables 2 and 3), greater than the minimum clinically important difference, which suggests that the reported difference is likely to be not only statistically, but also clinically significant.

Figure 1 Correlations between Olerud and Molander score and Euroqol-5D Index (a) and visual analogue score (b).

Open fractures^{3,34} and multiple concurrent orthopaedic injuries^{5,11} have previously been shown to correlate with poor functional outcomes. In the case of open fractures, this is possibly due to the high incidence of post-traumatic arthritis observed in open injuries, which has been reported to be as high as 100% in one study.¹¹ These findings are supported by our results, which have shown open fractures to be independent predictors of lower OMS on multivariate analysis. This could be explained by the observation that open fractures are usually observed with higher-energy mechanisms of injury, which may cause more complex fracture patterns and may disrupt the tenuous soft-tissue envelope of the talus, potentially leading to delayed healing or wound infection. Moreover, open talar fractures have been shown to correlate with increased risk of avascular necrosis,^{21,52} and therefore may require further surgical intervention or delay rehabilitation. However, our study demonstrates an independent effect of both open injuries and avascular necrosis on patient-related outcome measures.

Our results also suggest that increased age at the time of injury is a predictor of poor outcome. To our knowledge, this correlation has not previously been reported in talar fractures. Possible explanations for this finding include poorer physiological reserve⁵⁵ and longer rehabilitation time after injury⁵⁶ in older individuals, or poorer soft-tissue quality, which could increase the risk of infection.³⁷

The negative impact of fractures on health-related quality of life has been extensively documented in the elderly population,^{58,59} and more recently investigated in lower-limb trauma in particular following pilon^{40–41} and ankle^{42,45} fractures. Similar findings have been reported in the context of labral injuries in the hip.⁴⁴ The correlation of functional scores using the American Orthopaedic Foot

and Ankle Score⁴² and OMS^{41,42} with a poorer health-related quality of life has been documented following pilon and isolated medial malleolar fractures, although this relation has not previously been investigated in talar fractures. We have confirmed a similar relationship in the context of these injuries.

We acknowledge that this study has limitations. It is retrospective, and study numbers are relatively small. However, the number of patients in this study compares well with other related studies,^{2–4,11,56} and reflects the relative rarity of these injuries. Furthermore, with current numbers, several statistically significant relationships have been demonstrated, allaying fears of type II error. The decision not to contact patients who had sustained their injuries during a suicide attempt may be considered a limitation of this study; however, it was felt that revisiting the traumatic episode would not be in these patients' best interests.

Conclusion

Patient-reported functional outcomes following fractures of the talus are negatively influenced by increasing patient age, the presence of open fractures, and the subsequent development of avascular necrosis. Furthermore, there is a direct correlation between patient reported foot and ankle function and health related quality of life following these injuries.

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