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The role of primary plastic surgery in the management of open fractures

Charles M. Court-Brown [a,*], Calum S. Honeyman [b], Nick D. Clement [a], Stuart A. Hamilton [c], Margaret M. McQueen [a]

[a] Royal Infirmary of Edinburgh, Little France, Edinburgh EH16 4SA, Scotland
[b] Southmead Hospital, Southmead Way, Avon, Bristol BS10 5NB, United Kingdom
[c] St John's Hospital, Howden Road West, Howden, West Lothian EH54 6PP, Scotland

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SUMMARY

A study was undertaken to determine the requirement for primary plastic surgery in the treatment of open fractures. We reviewed 3297 consecutive open fractures in a 22-year period in a defined population. Analysis showed that 12.6% of patients required primary plastic surgery with 5.6% being treated with split skin grafting and 7.2% with a flap. Only 3.5% of open upper limb fractures required primary plastic surgery compared to 27.9% of open lower limb fractures. The fractures that required most primary plastic surgery were those of the femoral diaphysis and all fractures between the proximal tibia and the midfoot. The incidence of open fractures that require primary plastic surgery was $28/10^6$/year. The incidence in open upper and lower limb fractures was $5.3/10^6$/year and $22.7/10^6$/year respectively. Using these figures it is possible to estimate the numbers of open fractures that will require primary plastic surgery each year in the United Kingdom.

Introduction

It is well established that the successful treatment of many open fractures involves an 'orthoplastic' approach with their primary management being undertaken by both plastic surgeons and orthopaedic surgeons. Godina [1] showed that the successful management of open fractures necessitated immediate debridement and fracture stabilisation with definitive soft tissue cover being undertaken within 72 h. This philosophy has been refined [2,3] but there is universal agreement that early soft tissue cover is mandatory. Despite this there is virtually no information available about the extent of plastic surgery that is required in the management of open fractures and what little information there is relates only to open fractures of the tibia and ankle [4,5]. We know of no study that has investigated the role of primary plastic surgery in the complete spectrum of open fractures.

To investigate the requirement for primary plastic surgery in adults presenting with open fractures we have analysed 3297 consecutive open fractures, in patients ≥15 years of age, over a 22 year period in a defined population. We have calculated the prevalence of skin grafting and flap cover in all fracture types and we have also calculated the incidence of primary plastic surgery in open fractures to allow surgeons to estimate the requirement for primary plastic surgery in the management of open fractures in the United Kingdom. We believe that this will be useful following the introduction of Level I Trauma Centres.

Materials and methods

Clinical information on all patients aged ≥15 years of age who presented on an out-patient or in-patient basis to the Royal Infirmary of Edinburgh between 1988 and 2009 was collected and analysed. The Royal Infirmary of Edinburgh is the only hospital treating orthopaedic trauma in the City of Edinburgh, Midlothian and East Lothian. It also treats patients from adjacent areas and acts as a secondary referral centre for complex fractures and severe injuries in the South East of Scotland. However for this study all patients resident outwith the City of Edinburgh, Midlothian and East Lothian were excluded from analysis although patients injured outwith our population area but resident within it were included.

Clinical data up to 2005 was collected prospectively with later data being collected retrospectively from the hospital's computerised database. Since 2000 the Department of plastic surgery in St. John's Hospital in Livingstone has treated many of the severe hand and finger injuries and information about patients who

* Corresponding author. Tel.: +44 131 660 3281; fax: +44 131 660 4227.
E-mail address: charlescourtbrown@gmail.com (C.M. Court-Brown).

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presented with these open fractures, and were resident in our population area, was collected from the hospital's database.

The incidence of open fractures was calculated using the estimated population of patients aged ≥15 years in the City of Edinburgh, Midlothian and East Lothian for each year of the study [6]. This varied between 499,992 in 1988 and 556,473 in 2009 with the average being 515,913. The average population resident in our area between 1995 and 2009 was 523,819. This figure was used to calculate the incidence of primary plastic surgery during this period. Primary plastic surgery was divided into split skin grafting and flap cover with all different types of flap being combined. Three patients who had fingers re-implanted by plastic surgeons were included with the patients who had finger flaps undertaken. Late reconstructive plastic surgery procedures were not reviewed.

Demographic information was collected on all patients. This included name, address, date of birth, gender, date of injury, mode of injury, type of fracture, degree of soft tissue injury and the presence of other injuries. The severity of the soft tissue injury was assessed using the Gustilo classification [7,8]. The severity of patient injury was assessed using the Injury Severity Score (ISS) [9] which was derived from the Abbreviated Injury Scale (AIS) [10] of each fracture. In this analysis we have used an AIS of 3 for all long bone fractures, 2 for all carpal, hindfoot, midfoot and metatarsal fractures and 1 for all finger and toe phalangeal fractures. An AIS score of 1 was given for all Gustilo Type I and II open fractures and a score of 2 was given for all Gustilo Type III open fractures. Thus an isolated Gustilo Type I open finger fracture was given an AIS of 2 whereas a Gustilo Type IIIb open tibial fracture was given an AIS of 13. The ISS was computed by adding the squares of the three highest AIS scores in each patient.

All data were analysed using Statistical Package for Social Sciences version 17.0 (SPSS Inc., Chicago, IL, USA). Simple descriptive statistical analysis was undertaken for patient demographics, mode of injury, grade of open fracture, and plastic surgical intervention. The incidence of the open fractures was described according to anatomical site and according to plastic surgical intervention. Spearman's correlation was used to determine the relationship between the incidence of open fractures during the study period according to mechanism and plastic surgical intervention. To assess the change in risk of sustaining an open fracture, a grade III fracture, mechanism, and plastic surgical intervention a chi square test was used to calculate the significance of the odds ratio (OR). A p-value of <0.05 was used to define statistical significance.

Results

In the 22-year period between 1988 and 2009 3297 open fractures were treated. The average age of the patients was 45.7 years. There were 2294 (69.5%) fractures in males with an average age of 40.3 years and 1003 (31.5%) fractures in females with an average age of 56.6 years. During the study period 422 (12.8%) open fractures were treated with primary plastic surgery with 293 (12.7%) being in males and 129 (12.9%) being in females. The average ages of males and females undergoing primary plastic surgery were 38.0 and 61.0 respectively.

Table 1 shows the prevalence of the different open fractures. The fracture severity is indicated by the prevalence of Gustilo Type III [8] fractures and overall severity of injury to the patients by the ISS [9]. It shows that lower limb open fractures are more severe and the patients tend to be more severely injured. However the low overall ISS in upper limb fractures is skewed by the large number of isolated finger fractures and Table 1 shows that many patients with open upper limb fractures tend to be as severely injured as patients with lower limb fractures. The most severely injured patients often present with open, pelvic, diaphyseal femoral or distal femoral fractures.

Table 1 also shows that 10 patients died in hospital prior to primary treatment and that 50% of these patients presented with a tibial diaphyseal fracture. Overall 321 (9.7%) of the open fractures were treated by primary amputation but 255 (79.4%) of the

Table 1
The number and prevalence of all open fractures between 1988 and 2009. The prevalence of Gustilo Type III fractures and the average ISS is shown as the numbers of patients who did not have reconstructive surgery because of death or because of primary amputation or finger terminalisation.

	Fractures		Severity		No reconstructive treatment	
	No	%	GIII (%)	ISS	Died	Amputation/terminalisation
All fractures	3299	100	29.9	8	10	321
Upper limb	2028	61.5	20.5	5	1	258
Lower limb	1258	38.1	45.2	12	9	63
Pelvis	11	0.3	18.2	27	0	0
Scapula	4	0.1	25.0	0	0	0
Clavicle	11	0.3	0	6	0	0
Proximal humerus	15	0.5	13.3	12	0	0
Humeral diaphysis	32	1.0	15.6	15	1	0
Distal humerus	31	0.9	32.2	13	0	0
Proximal forearm	70	2.1	14.2	13	0	0
Forearm diaphysis	109	3.3	12.8	11	0	0
Distal radius/ulna	253	7.7	3.6	11	0	0
Carpus	6	0.2	66.6	7	0	0
Metacarpus	131	4.0	9.2	6	0	3
Fingers	1366	41.4	25.5	3	0	255
Proximal femur	2	0.1	0	26	0	0
Femoral diaphysis	75	2.3	64.0	18	1	4
Distal femur	35	1.1	68.6	19	0	3
Patella	66	2.0	28.8	9	0	1
Proximal tibia	46	1.4	50.0	14	0	3
Tibial diaphysis	491	15.9	50.1	14	5	14
Distal tibia	47	1.4	48.9	13	1	0
Ankle	171	5.2	45.0	13	1	1
Talus	9	0.3	66.6	10	0	0
Calcaneus	31	0.9	71.0	12	1	5
Midfoot	10	0.3	80.0	12	0	2
Metatarsus	62	1.9	51.6	7	0	5
Toes	213	6.5	19.2	3	0	25