Missed orthopaedic injuries in adult trauma patients at a major trauma centre

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Abstract

Introduction: The primary aim was to determine the incidence of missed orthopaedic injury for adult trauma patients at St George's Hospital, London, a Major Trauma Centre. The secondary aim was to analyse missed injuries and comment on risk factors. **Method:** Trauma patients were recorded prospectively at the daily trauma meeting by a researcher from July – September 2012. The researcher attended clinical activities and reviewed the patient notes and radiologist reports daily whilst each patient was an inpatient until discharge. Missed injuries were fractures or dislocations discovered after 12hrs. The notes for missed injury patients were reviewed again at six months. Missed injury details were recorded/analysed. **Results:** 343 adult trauma patients were referred to trauma and orthopaedics in the three month study period. 5 (1.5%) had a missed injury. 148 (43.1%) had an ISS>15. All missed injuries occurred in these major trauma patients, incidence 5/148 (3.4%). Four were extremity injuries, one was cervical. All missed injury patients had a GCS 15/15, were admitted outside normal working hours, were direct admissions and had whole-body CT. **Conclusions:** At 3.4% our missed injury incidence is comparable to those published from similar centres. This provides recent London data following restructuring of trauma networks.

Keywords: trauma, polytrauma, emergency, injury, fractures, error

Abbreviations

GCS – Glasgow Coma Score

ISS – Injury Severity Score

MTC – Major Trauma Centre

SGH – St George's Hospital

RTA - Road Traffic Accident

Introduction

Despite significant advance in trauma care since the invention of Advanced Trauma Life Support (ATLS) principles in 1978, published missed injury rates for trauma patients worldwide suggest that the rate of this important adverse event has not significantly declined [1-4].

Missed injuries are important primarily because they are a patient safety issue. A meta-analysis of 17 papers found that 15-22% of missed injuries required a change in management [1]. Others have reported significant increases in markers of morbidity such as length of hospital stay or units of blood transfused [5]. There is also evidence that having a missed injury increases the risk of death [6] and can directly cause death [7,8] including at autopsy where as many as 6.5% of trauma deaths have been reported to be directly attributable to an undiscovered missed injury [9,10]. Of secondary importance, even clinically insignificant missed injuries reflect badly on the effective working of the trauma team, lead to patient dissatisfaction with possible legal action [11-15] and have potential to skew the appropriate classification of trauma severity data [9].

Whilst many centres globally have published their missed injury rates, in the context of modern trauma care in England, there have been only two hospitals which have (Nottingham in 2007 and Coventry in 2011) [16,17] and there is no recent data for London. In 2010, the National Health Service implemented an extensive overhaul of trauma services, including the establishment of four Major Trauma Centres (MTCs) for London, one of which is St George's Hospital (SGH). Each is fed by smaller trauma units at district general hospitals in their respective regions and SGH serves hospitals in South-West London. In the year after MTC status, there were 560 trauma patients who triggered the acute trauma team response and of these 298 were for major trauma (Injury Severity Score (ISS) >15) [18].

There is a need for data on the effectiveness of the new system of trauma networks. This data is needed as a standard by which trauma departments can compare their performance. It is also important to recognise and quantify the underlying risk of missed injury in order to inform patients and clinicians.

Our primary aim was to answer the question: what is the incidence of missed orthopaedic injury for adult major trauma (ISS >15) patients at SGH?

Our secondary aim was to examine the details of the missed injuries in order to identify and make comment on potential risk factors for missed injury. These included: the time of admission being outside of normal working hours, having a reduced Glasgow Coma Score (GCS) on admission, being a secondary transfer from another hospital (rather than a direct admission) and the mode of radiological imaging (whole-body CT or selective).

Method

A missed injury was defined as any new orthopaedic injury (i.e. fracture or dislocation) discovered >12 hours after the documented A&E arrival time. The data were obtained prospectively, with a researcher sitting in the daily trauma meeting every weekday for three months (July – September 2012) collecting details of all adult trauma admissions referred to trauma and orthopaedics from the previous day or weekend. The researchers were senior medical students at the affiliated St George's University and were not part of the regular trauma team involved in patient care. The patients were not aware that the project was ongoing and it did not alter the regular care they received. Regular clinicians in the team were aware of the researchers being present as if on a university training placement but not the details of the data collection. The researchers attended clinical activities and reviewed the patient notes and radiologist reports daily whilst each patient was an inpatient up to the end-point of discharge from hospital. The notes for those patients who had a missed injury were reviewed again six months later to obtain the full patient journey and medium-term outcome of their missed injuries. Patient demographics, time of admission, GCS on arrival, grade of reviewing clinician, transfer status, radiographic images taken, radiation dose for whole-body CT and missed injury details were recorded and used for analysis. The project was authorised and registered with the trauma audit and research department.

Results

Demographic data and results are shown in **Table 1**. There were 343 adult trauma patients referred to trauma and orthopaedics in the 3 months from July – September 2012. 5 (1.5%) of these had a missed orthopaedic injury. 148 (43.1%) patients had an ISS>15 and all missed injuries occurred in these major trauma patients. The major trauma missed injury incidence was 5/148 (3.4%). 12 (3.5%) patients died from their injuries and none of these had a missed injury.

Table 1. Results and Demographic Data

Dates, m 'yr	Jul-Sept '12
Adult Trauma Patients, n	343
Males, n (%)	248 (72)
Females, n (%)	95 (28)
Mean Age, yrs (SD)	42 (20)
Major Trauma Patients (ISS>15), n (%)	148 (43)
Trauma patients with ISS = 1, n (%)	105 (31)
Mean ISS (SD)	14 (15)
Patients with Missed Injury, n (%)	5 (1.5)
Major Trauma Patients with Missed Injury, n (%)	5 (3.4)

Table 2. Mechanisms of Injury

Cohort	POST
Blunt, n (%)	304 (89)
Penetrating, n (%)	39 (11)
RTA, n (%)	138 (40)
Fall, n (%)	114 (33)
Assault/Self-harm, n (%)	54 (16)
Sport, n (%)	16 (5)
Other, n (%)	21 (6)

The mechanisms of injury are shown in **Table 2**. All the missed injuries occurred in blunt trauma patients and in four cases the mechanism was a road traffic accident (RTA) and in one it was a fall. The details of the missed injuries themselves, including how they were missed, are shown in **Table 3**.

Table 3. Detailed Tabulation of the Missed Injury Patients and Their Missed Injuries from July-September 2012; # denotes a fracture.

Age(Sex) Mechanism ISS GCS Time Day	Missed Injury	How It Was Missed	Interval In Days	How It Was Detected	Clinical Significance
60(M) RTA 24 15 00:08 Thurs	# L fibula	CT: whole-body (Extremity not scanned)	12	Radiograph: tibia & fibula	<ul style="list-style-type: none"> • Leg swelling investigated for DVT • Anticoagulation had to be stopped as haematoma was forming • Surgical intervention likely would have been indicated but not performed due to delay • Poor alignment of healed bone at followup
36(M) Fall 18 15 20:30 Sat	# (displaced multifragment) L radial head	CT: whole-body (Extremity not scanned)	11	Radiograph: elbow	<ul style="list-style-type: none"> • Surgical intervention likely would have been indicated but not performed due to delay
48(M) RTA 17 15 02:24 Sun	# R occipital condyle	CT: whole body	<1 (16hrs)	Tertiary survey	<ul style="list-style-type: none"> • Unstable neck # immobilised • Miami J collar applied for 6 weeks • Minimal delay but shows importance of tertiary survey
40(M) RTA 20 15 16:51 Sun	Dislocation L acromioclavicular joint	CT: whole-body	1	Radiograph: shoulder	<ul style="list-style-type: none"> • Outpatient surgical intervention was required • Minimal delay and no adverse outcome
26(M) RTA 22 15 04:28 Thurs	# L calcaneus (intra-articular affecting calcaneocuboid joint)	CT: whole-body Radiograph: ankle (Patient uncooperative)	3	Repeat radiograph: ankle	<ul style="list-style-type: none"> • Management not altered. Highlights particular risk to uncooperative patients

The Glasgow Coma Score (GCS) on admission for all missed injury patients was 15/15. All missed injuries happened outside of normal working hours, with two happening on the weekend (at 16:51 and 20:30) and three on a weekday (at 00:08, 02:24 and 04:28). For all missed injury patients, the grade of the doctor conducting the primary and secondary survey was either consultant or registrar and where it was a registrar initially, a consultant conducted the tertiary survey. The grade of the radiologist reporting on scans was also either consultant or registrar and where it was a registrar initially a consultant conducted a second review of the scans.

16/343 (4.7%) patients were secondary transfers from another hospital and none of these had a missed injury. Of the major trauma patients, 44/148 (30%) had selective imaging and 104 (70%) had whole-body CT. None of the selectively imaged patients had a missed injury. The mean dose-length product from whole-body CT was 2.5Gy/cm.

Discussion

At 3.4% for major trauma patients the missed injury incidence for SGH is low, in keeping with published rates from similar MTCs [6,15-22]. It is difficult to compare published missed injury rates between studies due to differences in sampling, methodology and definitions of missed injuries. Our figure can be expected to be skewed downwards by the fact that we included only inpatient orthopaedic injuries and only missed injuries which were ultimately discovered (and not those unseen missed injuries which never came to the attention of the team). It can be expected to be skewed upwards due to the strict 12 hour definition meaning we are in fact reporting a delay in diagnosis (e.g. one of our missed injuries was discovered at 16 hours by the tertiary survey), the fact that we included all missed injuries regardless of their clinical significance, the prospective study design making it less likely that missed injuries were not accounted for in the data collection [15] and the significant proportion of major trauma in our study population [19]. Nevertheless, our incidence can be compared to a literature review of 17 transnational papers published between 1980 and 2006 which found a mean incidence of 9% (range 1.3-39%) [1]. In the UK, incidences of 4-22% have been reported [16,17,23]. The highest incidence reported in the literature was 65% in Australia [8]. This was due to the comprehensive inclusion criteria of that study, for example, the authors included soft tissue injuries and injuries found at autopsy. By including missed orthopaedic injuries only we increased the likelihood of injuries being objectively verifiable and of adequate

severity to warrant inclusion. In previously published studies, they have also tended to make up the majority of significant missed injuries [15,22,24].

This is an appropriately low missed injury incidence for major trauma patients at a MTC and can be used as a standard by which to compare performance. It also shows clinicians and patients that even in a modern major trauma centre, a significant baseline complication rate of missed injury persists. Elsewhere, it has even been suggested that a certain low level of missed injury should be accepted, as to completely eliminate it would require an inappropriate allocation of resources such as consultant time and overuse of scans [13].

Whilst our sample size is comparable to many published missed injury series, it is not an especially large cohort and this combined with our low rate of missed injury meant that we only had five missed injury patients. Therefore the power of the study to bring out risk factors for missed injury is limited. As far as comment is possible, it is interesting that all our missed injury patients had a GCS of 15/15. Others have also found that a reduced GCS is not a risk factor for missed injury [8] whereas some have published findings that a GCS below 8 increased the risk of having a missed injury by a factor of three [9]. It is also noteworthy that all our missed injuries happened out of normal working hours, in keeping with findings which others have published [8,25,26].

None of our missed injury patients were secondary transfers. This group had previously been identified as having worse outcomes in trauma [27]. Our findings suggest that with appropriate mechanisms in place to receive transfers, such as online image transfer prior to arrival, this group is not at increased risk of missed injury.

All our missed injury patients had whole-body CT initially, which did not detect injuries of the fibula, radial head, occipital condyle, acromioclavicular joint and calcaneus. This warns against over-reliance on whole-body CT, especially for extremity and cervical spine injuries, known to be anatomical areas at risk of missed injury [12,21,28]. It is known from a previous departmental audit [Unpublished Observations, Roche CD & Bishop T, 2011] that in February 2011 our department performed whole-body CT on 49% of our major trauma patients. Compared to that cohort, we whole-body CT scanned 70% of our major trauma patients, which is similar to the proportion receiving whole-body CT elsewhere in England [17]. The mean dose-length product of 2.5Gy/cm recorded for these scans equates to an effective radiation dose to the tissues of approximately 45mSv (roughly 450 chest radiographs), an estimate supported by the literature [29]. Clinicians

should be aware of the magnitude of the whole-body CT radiation dose and the limitations of whole-body CT which should not replace the need for meticulous clinical examination.

Conclusions

At SGH the missed injury incidence for adult major trauma patients from July-September 2012 was 3.4% which is comparable to published rates from similar centres. This provides recent data for London following the restructuring of trauma networks.

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