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Acute Compartment Syndrome: Do guidelines for diagnosis and management make a difference?

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ABSTRACT

Background: The best outcomes following Acute Compartment Syndrome (ACS) are attributed to early diagnosis and treatment. National guidelines were issued in the United Kingdom in 2014 (BOAST 10) to standardise and improve management. We analysed standards of diagnosis and management before and after the introduction of the guidelines.
Methods: We retrospectively reviewed the data of all patients with ACS requiring fasciotomy between March 2010 and May 2015 across four Major Trauma Centres (MTCs) in the Northwest of England. We analysed the pooled data for variations between the centres and the effect of BOAST10 implementation.
Results: 75 fasciotomies were recorded, with trauma being the cause in 42 cases (56%). The commonest site was the leg (44, 59%) followed by the forearm (15, 20%). The median time from decision to operate to fasciotomy was 2 h (range 0–6) and thereafter a median of 2 days (1–7) until a second visit. The practice across the four centres was similar up to diagnosis and treatment, but there was significant variation in practice after fasciotomy. The BOAST guidelines did not improve the time to surgery, time to second visit nor the recording of clinical signs. 21 patients had severe complications, including one death and 4 amputations.
Conclusions: There continues to be significant variability in the definitive management of ACS. National guidelines do not appear to make a discernible impact on practice, and additional methods of ensuring safe management of this critical condition seem warranted.

Introduction

Acute compartment syndrome (ACS) is an uncommon but serious condition associated with high morbidity and mortality [1,2]. The literature about this topic is well established, but few epidemiological studies exist [3–5].

In the United Kingdom, national guidelines on the management of acute compartment syndrome of the limbs were published for the first time by the Trauma Group of the British Orthopaedic Association (BOAST 10) in May 2014 [6].

Our primary aim was to study the impact of the BOAST 10 guidelines on practice across 4 Major Trauma Centres (MTCs). We chose to explore the impact of the recently introduced BOAST10 guidelines with respect to the following standards: Standard 3 *"The key clinical findings are pain out of proportion to the associated injury and pain on passive movement of the muscles of the involved compartments. Limb neurology and perfusion, including capillary refill and distal pulses, should be clearly documented but do not contribute to early diagnosis of the condition."*, Standard 7 *"Compartment syndrome is a surgical emergency and surgery should occur within an hour of the decision to operate"* and Standard 12 "(. . .) *All patients should undergo re-exploration at approximately 48 hours, or earlier if clinically indicated (. . .)*

There is a perception that the aetiology of ACS is changing, with an increased prevalence of non-traumatic causes. The secondary aims were to look for variations in practice, and the aetiology of ACS in a large geographic area, the North-West of England.

Methods

We performed a retrospective cohort study of all patients with ACS admitted to the four Level 1 Major Trauma Centres (MTC) in

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the North West of England (the Royal Liverpool University Hospital, Aintree University Hospital, Royal Preston Hospital and Salford Royal Hospital) at the time of the study. The catchment area is of a population of about seven million. Six investigators used a standardised data collection proforma across the four hospitals. Electronic patient records were searched for ICD-10 codes for fasciotomies (T54 and T55) between 1st May 2010 and 1st May 2015 with individual case reviews to confirm the indication was ACS. All patients who underwent an emergency fasciotomy of a limb were included. Patients who had elective or scheduled fasciotomies for chronic compartment syndrome were excluded.

Data collected included patient demographics, cause of ACS, site, documentation of diagnostic signs and symptoms, use of adjuncts to measure compartment pressures,use of split skin grafting, complications and timing of events: arrival to hospital; diagnosis; fasciotomy (initial surgery); further theatre visitts and final closure.

Data was analysed using SPSS statistics software version 24.0 (SPSS Inc., Chicago, Illinois). The majority of the data was non-parametric, and non-parametric tests were used throughout the study. The Kruskal-Wallis with Bonferroni correction for multiple tests was used to analyse more than two groups and Mann Whitney *U* test was used for two group analysis. The correlation between timing and number of visits and final wound closure was performed using Spearman rho test. A p-value <0.05 was deemed significant.

Results

Seventy-five patients across the four centres were identified. The demographics are presented in Table 1.

The aetiology and anatomical site of ACS are listed in Tables 2 and 3 respectively.

The causes in the non-traumatic other category were varied and are listed below: 4 related to intravenous drug injection; 2 spontaneous haematomas in patients with no bleeding disorders nor on anticoagulants; 2 lying unconscious from opiate overdose; 1 lying unconscious from alcohol abuse; 1 intravenous fluid extravasation in a hand; 1 ruptured Baker's cyst; 1 arm superficial vein thrombosis; 1 leg cellulitis; and 1 exercise induced rhabdomyolysis (bilateral). In 11 cases, no clear diagnosis leading to ACS was found documented in medical or electronic notes, but all were confirmed as ACS at time of fasciotomy.

The recording of diagnostic signs varied slightly across the hospitals, with a combined median of 2 out of 3 (AUH 1.5, PRH 2, RLUH 2 and SRH 1.5).Most relevantly, there was no change since the introduction of the guidelines (p 0.93), which stipulate all three are recorded.

There was no significant difference between the 4 centres in timing from diagnosis to surgery and from fasciotomy to second visit (p 0.16 and 0.18 respectively). However there was a difference in timing to definitive wound cover across the centres (p 0.04). There was no difference between pre and post BOAST10 groups in time to fasciotomy (2 h, BOAST standard: 1 h), second visit (2 days, BOAST standard: 2 days) and definitive closure (p 0.42, 0.72 and 0.28).

There was a positive correlation between the time from diagnosis to fasciotomy and the number of visits to theatre (R = 0.73, P 0.0001). However, there was no significant correlation between the use of split skin grafts and the number of theatre visits post fasciotomy, (R = 0.21, p 0.95); and time to definitive wound cover (R = 0.15, p 0.26) as assessed by Spearman Rho coefficient.

We list the recorded complications at a minimum of 1-year post surgery in Table 4.

Table 1
Distribution of patient numbers between units, showing median and mean age and sex distribution. Abbreviations: Aintree University Hospital (AUH), Royal Preston Hospital (RPH), Royal Liverpool Hospital (RPL), Salford Royal Hospital (SRH).

Centre	Total cases	Median age	Mean age	Male	Female
AUH	20	35	40	14	6
RPH	21	34	39	14	7
RLUH	22	40	41	15	7
SRH	12	38	43	9	3
Combined	75	37	41	52	23

Discussion

The wealth of previous data on ACS has been from single centres, and the aetiology in these studies may be reflective of the local population. This first multi-centre series of ACS in the United Kingdom provides a contemporaneous set of demographics and is widely geographically distributed.

Our data suggests that the mean age of occurrence is about 10 years older than the series reported by McQueen [4], (41 (c/f 32) and that there is a significant increase in females with ACS (male to female ratio ~ 5:2 (c/f ~ 10:1)).

Trauma was the major cause in our series, with tibial fractures being the largest sub-group. However, forearm fractures dominated that the post-fracture surgery group. None of the 4 centres used routine pressure monitoring after tibial fracture treatment, but, given that the 4 hospitals dealt with major trauma regularly, it is unlikely that an ACS after tibial nailing would be missed.

We note a significantly higher proportion of non-traumatic causes of ACS, particularly with anticoagulant use. These are increasingly significant factors with an ageing population and the wide introduction of new oral anticoagulants, which are irreversible [7]. Warfarin was implicated in the single death in our series and in one of the amputations.

Intravenous drug use was the cause in 4 cases (5.3%). This may reflect the populations surrounding our four MTCs, based in major cities [8], a limitation to the generalisability of our study.

Diagnosis was largely clinical, with only 26 patients (34%) receiving intra-compartmental pressure monitoring. It was not possible to analyse whether monitoring impacted diagnosis or management. BOAST recommends undertaking pressure monitoring where clinical signs are not convincing, not as a routine.

The median time to fasciotomy was 2 h after diagnosis, and the median time for a revisit was 2 days. We acknowledge the difficulty in establishing the exact time of onset of this evolving condition. It may be that our retrospective study was underpowered to measure the data with enough precision (standard 7, 1 h) to demonstrate any effect. The notes are sometimes written in retrospect and while using admission time and time of onset of symptoms as a surrogate is possible, the quality of data is likely to be compromised. Notwithstanding these limitations, the introduction of the national guidelines emphasising emergency surgery did not appear to impact the diagnosis or treatment of ACS.

The time to final closure varied significantly between centres (6–11 days). This may reflect different surgical practices and/or theatre list utilisation. Use of split skin grafting as definitive wound closure also varied, likely due to varying access to plastic surgery assistance. BOAST10 recommends involvement plastic surgeons for tissue coverage without suggesting technique. However it made no difference in the time to definitive wound cover nor the number of surgical visits post fasciotomy.

We anticipated that the widely publicised BOAST10 guidelines would reduce times and improve outcomes. We analysed their

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