Amputation and the assessment of limb viability: perceptions of two hundred and thirty two orthopaedic trainees

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ABSTRACT

INTRODUCTION The management of complex extremity injury, which may require assessment of limb viability and performance of amputation, is a challenge to those involved in its emergent and definitive care. Concern exists regarding the exposure of orthopaedic trainees to such cases due both to changes in training and centralisation of trauma services.

SUBJECTS AND METHODS This is a web-based observational study by survey, investigating the confidence and perceived adequacy of training of UK orthopaedic specialist trainees in the assessment of limb viability and amputation surgery.

222 responses from 888 trainees were required to achieve a < 5% error rate with 90% confidence; 232 surveys were completed.

RESULTS Trainee confidence in dealing with the assessment of limb viability is high despite infrequent exposure to cases. The majority of trainees perceive their training in limb viability assessment as adequate. For performance of amputation, exposure is minimal, confidence is lower and 36% of trainees regard their training as inadequate.

CONCLUSIONS Limb viability assessment is an area in which trainees feel confident and well trained. There is, however, a perceived training inadequacy in amputation surgery and a corresponding lack of confidence for many trainees, irrespective of training year. This is the first study to offer an insight into specific training experiences of junior orthopaedic surgeons at a national level and it should drive the development of opportunities for trainees to develop skills in amputation surgery.

KEYWORDS

Amputation – Limb salvage – Penetrating wounds – Leg injuries – Arm injuries – Education

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Mutilating extremity trauma has challenged surgeons over many centuries, with amputation for limb injury and gangrene being described by Paré as early as 1564.¹

Often associated with warfare,² our understanding of such injury has advanced primarily through repeated experiences gained in the combat environment.³ Recent conflicts are no exception with considerable numbers of significant extremity injuries still being encountered.⁴ In peace time, road traffic accidents and industrial trauma are the main causes – particularly in the developing world.^{5–7}

In the UK, complex limb trauma is predominantly dealt with by orthopaedic surgeons with increasing input from allied specialities including plastic surgery. Although a field reliant heavily on the apprenticeship model, orthopaedics has had to evolve alongside other surgical disciplines due to advancing technology, training legislation and restrictions on junior doctors working hours.^{8–11}

Alterations in surgical training through diminishing working hours is not the sole factor for concern regarding junior

surgeons' exposure to cases of significant injury. There has been a growing interest in the provision of trauma care in its generality in the UK over the last 20 years.¹² Trends and concerns over trauma care services have been described,^{13–15} culminating in a move towards recommendations for centralisation of trauma services.¹⁶ Recent evidence suggests that sub-specialist regional trauma centres have a positive impact on preventable death from significant injury.¹⁷ There is concern, however, that alongside changes in working hours, such centralisation of trauma provision will further contribute to decreasing exposure of orthopaedic trainees to limb-threatening trauma.

As a result of these changes, anecdotal concern exists in the popular press regarding surgical training.¹⁸ The capacity of orthopaedic surgeons of the future to manage competently high energy, limb-threatening extremity injury is one obvious facet of this concern. The aim of this paper is to provide an insight into current UK orthopaedic trainees perceived experiences in the management of limb-threatening trauma.

Subjects and Methods

A web-based survey was designed (Survey Monkey, Portland, OR, USA) and a sample size determined in order to establish the return rate required to provide a result representative of the population of orthopaedic surgeons in training. This was ascertained using an on-line survey sample size calculator (<www.custominsight.com>), a tool using a series of calculations written in JavaScript. This allows incorporation of population size, estimation of likely response rate and proposed confidence and error levels.

The population of orthopaedic surgeons in training is currently around 1200 in various grades. In order to gain a representative sample, a minimum of 222 returns were

required. This allowed 90% confidence with a 5% error rate in reporting the survey findings. A survey return of 25% was deemed realistic and, so as to yield 222 returns, 888 junior orthopaedic surgeons were contacted. The trainees were contacted by email containing a link to the survey and all returns were anonymous.

The survey investigated a number of scenarios representative of complex trauma management including limb viability assessment and amputation.

Each question followed a uniform layout (Appendix 1), utilised a previously validated confidence assessment tool,¹⁹ and addressed exposure to index cases, status of operative role and perceived training need. In total, 232 trainees responded.

Results

Assessment of limb viability

Trainees were given the statement: 'with regard to the assessment of limb viability following complex trauma:'. Answer options as described in Appendix 1 with the exception of operative role were available.

Amputation for extremity trauma

Trainees were given the statement: 'with regard to amputation following extremity trauma:'. Answer options as described in Appendix 1 were available.

Overall exposure to cases, perceived confidence and adequacy of training with regards to limb viability assessment and the practical application of amputation surgery is illustrated in Figure 1A–D.

Discussion

Traditionally the realm of the war surgeon; proficiency in the management of complex trauma and extremity amputation is also required in civilian practice. This is especially apparent in the context of recent terrorist atrocities.^{20,21}

Systems exist to aid decision making in limb viability assessment.^{22–26} Such 'scoring' should, however, be viewed with caution and certainly cannot be used in isolation.²⁷ In the military population, in which there has been a wealth of recent experience in the management of these casualties, the use of scoring systems is unhelpful.²⁸

The inability of scoring systems to predict functional outcome in particular is demonstrated through evidence suggesting comparable long-term functional results in both reconstructed and amputated limbs.^{29,50} A key distinction here must be made between viability and ultimate function in the assessment of limb trauma. Whilst a limb may be viable in terms of circulation, functional viability of the same limb in terms of catastrophic bone and muscle loss, nerve discontinuity and chronic, debilitating pain is a different matter. This is particularly challenging in lower limb fractures as sensation in the sole of the foot is not a reliable indicator of nerve injury and ultimate outcome.⁵¹

It can be seen, therefore, that assessment is multifaceted. Previously confined to absolute ischaemic viability – the long-term functional viability is now becoming increasingly recognised as a major consideration.

Acknowledging the challenging nature of these injuries, a number of guidelines have been issued to inform best management of complex extremity injuries and primary amputation for trauma.^{32,55} Key recommendations in terms of general management and decision making from these documents are summarised in Table 1.

Resulting both from these recommendations and the centralisation of trauma services, the care of patients with

limb injuries of questionable viability will increasingly be carried out in regional centres.

There remains, however, as described, a cohort of significantly injured patients whose care will fall on those with less experience and resources as they are unable to be transferred for such specialised care. This identifies a requirement, despite sub-specialisation, for all consultant orthopaedic surgeons to be adequately trained in this field. With scoring systems providing limited support in decision making, adequate training and exposure to cases as a trainee must form the basis of gaining those key aspects vital to decision making as a junior consultant – confidence and experience.

Limb viability assessment

Our study shows that perceived confidence in the assessment of limb viability following significant extremity trauma is high with 64.7% of all trainees either reporting themselves confident in some cases or fully confident in all cases (Fig. 1A). This perception of confidence increases with time spent in training. Exposure is sporadic, however, and most trainees report an expectancy to assess limb viability at intervals of every 6 months or longer (Fig. 1B). Overall, the perception of the majority of those responding to the survey is that their training in the assessment of limb viability is adequate (Fig. 1C). The preponderance of work regarding scoring systems in the literature may, in part, have an impact on the perceived levels of confidence despite such low case exposure.

Primary amputation for trauma

Over half of current UK orthopaedic trainees demonstrate a lack of confidence in dealing with the practical application of amputation in trauma. Although perceived confidence increases with time spent in training, over half of trainees are either not confident or lacking confidence in amputation surgery (Fig. 1A). Of note, less than one-third of trainees having completed their training reported being fully confident.

Over half of trainees report either never having been involved in such a case or, if involved, being so only once every 2 years (Fig. 1B). Over 70% of trainees would be either assisting or operating with their trainer scrubbed for such cases (Fig. 1D). Overall, a significant proportion of trainees report that their training in amputation surgery is inadequate. This perceived inadequacy is unaffected by time spent in training (Fig. 1C).

Concern over surgical training in the UK is not confined to orthopaedics. Similar problems of confidence and capability exist in surgeons dealing with vascular and thoracic trauma.⁵⁴ Improvements in health and safety legislation and a decrease in high-energy trauma from road traffic accidents has affected the nature of casualties presenting to

Table 1 Key recommendations in terms of general management and decision making

- Minimal wound handling: intervene only to remove gross contamination and to allow photography, then cover in saline soaked gauze and an impermeable film to prevent desiccation. The limb should be immobilised early
- Intravenous antibiotics to be administered as soon as possible, ideally within 3 h of injury: Co-amoxiclav (1.2 g) or Cefuroxime (1.5 g) 8-hourly and continued until wound debridement. Clindamycin (600 mg, 6-hourly) to be used if penicillin allergy is a concern
- Early and regularly repeated systematic vascular and neurological assessment, especially after splinting and fracture reduction
- A combined plan for the management of both the soft tissues and bone should be formulated by the plastic and orthopaedic surgical teams and clearly documented
- Centres that cannot provide combined plastic and orthopaedic surgical care for severe open tibial fractures should have protocols in place for the early transfer of the patient to an appropriate specialist centre
- The primary surgical treatment (wound excision and fracture stabilisation) of severe open tibial fractures only should take place in a non-specialist centre if the patient cannot be transferred safely
- Senior orthopaedic and plastic surgeons should perform the initial surgery
- Immediate surgery is required for both vascular impairment (ideally within 3–4 h of injury) and compartment syndrome
- The decision to proceed with primary amputation should be taken by two consultant surgeons and, if possible, in conjunction with discussion with the patient and their family
- Indications for consideration of primary amputation include: a warm ischaemic time exceeding 4–6 h, segmental muscle loss affecting more than two compartments and segmental bone loss affecting more than one-third the length of the tibia
- Absent or reduced plantar sensation at initial presentation is not an indication for amputation
- If amputation is to be performed, trans-tibial or trans-femoral levels are preferred to a through knee amputation

trauma surgeons with a negative impact on training opportunities.³⁵ Neither is this problem unique to the UK – trainees in Australia and Canada demonstrate similar concerns.^{36,37} The same issue has led to a call for re-structuring of the education of trauma surgeons in the US alongside an evolution in the way that the trauma service is provided.^{38–40}

Study limitations

There are, of course, limitations to this study. Establishing a snapshot of current practice involves sampling the opinions of as many members of the population in question over a short period of time. An overall summary has been provided across all training years. To enable brevity of reporting, the break-down of the exposure, confidence, adequacy of training and operative role for individual groups by training year, whilst collected, is not included. As may be expected, it is seen that exposure to cases and perceived training adequacy does not change according to seniority whilst confidence and status as operating surgeon increase with time.

Previous works on issues in training³⁴ have produced response rates of less than 50%. We predicted a return rate

of around 25% and this allowed for efficient sampling of the population. It is appreciated that whilst does not establish the perceptions of all trainees, it does allow us to reflect on the current perceptions of the trainee body as a whole.

Conclusions

This study presents, for the first time, the experiences of UK orthopaedic trainees in the management of complex extremity injury. Exposure to cases is infrequent and, whilst a perceived confidence exists in the assessment of limb viability, there is a lack of confidence in trainees regarding the practical application of that knowledge.

The trend of decreasing trauma operative exposure is not unique to orthopaedics or UK surgical trainees in general. With the advent of increasingly stringent legislation on junior doctors' working hours and increasing centralisation of trauma services, it is anticipated that current areas of inadequacy will not improve and focused training in the future will be required.

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References

- Kirkup J. Introduction and sources. In: Kirkup J. (ed) *A History of Limb Amputation*, 1st edn. London: Springer, 2007; 1-1.
- Helling TS, McNabney WK. The role of amputation in the management of battlefield casualties: a history of two millennia. *J Trauma* 2000; **49**: 930-9.
- Jovanovic S, Wertheimer B, Zelic Z, Getos Z. Wartime amputations. *Mil Med* 1999; **164**: 44-7.
- Owens BD, Kragh Jr JF, Macaitis J, Svoboda SJ, Wenke JC. Characterization of extremity wounds in Operation Iraqi Freedom and Operation Enduring Freedom. *J Orthop Trauma* 2007; **21**: 254-7.
- Richter M, Blauth M, Otte D, Tschern H. Fractures of the upper extremity in restrained automobile front seat passengers. Injury pattern and incidence in relation to accident mechanism. *Unfallchirurg* 2000; **103**: 364-70.
- Boyle D, Parker D, Larson C, Pessoa-Brandao L. Nature, incidence, and cause of work-related amputations in Minnesota. *Am J Ind Med* 2000; **37**: 542-50.
- Abbas AD, Musa AM. Changing pattern for extremity amputations in University of Maiduguri Teaching Hospital, Nigeria. *Niger J Med* 2007; **16**: 330-3.
- Gorman PJ, Meier AH, Rawn C, Krummel TM. The future of medical education is no longer blood and guts, it is bits and bytes. *Am J Surg* 2000; **180**: 353-6.
- UK Modernising Medical Careers Co-ordinating Group. *A Reference Guide for Speciality Training within the United Kingdom: The Gold Guide*. 2008 <<http://www.mmc.nhs.uk/pdf/Gold%20Guide%202008%20-%20FINAL111.pdf>>.
- Calman KC. *Hospital doctors: training for the future*. London: Department of Health, 1993; 1.
- Anwar M, Irfan S, Daly N, Amen F. EWTD has negative impact on training for surgeons. *BMJ* 2005; **331**: 1476.
- Clark C. Improving the management of major trauma. *Br J Anaesth* 1990; **64**: 139-41.
- Lecky F, Woodford M, Yates DW. UK Trauma Audit and Research Network. Trends in trauma care in England and Wales 1989-97. *Lancet* 2000; **355**: 1771-5.
- Lecky FE, Woodford M, Bouamra O, Yates DW. Trauma Audit and Research Network. Lack of change in trauma care in England and Wales since 1994. *Emerg Med J* 2002; **19**: 520-3.
- Lecky FE. Trauma care in England and Wales: is this as good as it gets? *Emerg Med J* 2002; **19**: 488-9.
- NCEPOD. *Trauma: Who Cares?* 2007 <http://www.ncepod.org.uk/2007report2/Downloads/SIP_report.pdf> [accessed 30 July 2009].
- Davenport RA, Tai N, West A, Bouamra O, Aylwin C, Woodford M *et al*. A major trauma centre is a specialty hospital not a hospital of specialties. *Br J Surg* 2010; **97**: 109-17.
- Devlin K. 100 days to save surgeons' training, leaders warn. *The Daily Telegraph* 20 April 2009; Health News: 5189023-5189023.
- George JT, Warriner DA, Anthony J, Rozario KS, Xavier S, Jude EB *et al*. Training tomorrow's doctors in diabetes: self-reported confidence levels, practice and perceived training needs of post-graduate trainee doctors in the UK. A multi-centre survey. *BMC Med Educ* 2008; **8**: 22.
- Mohammed AB, Mann HA, Nawabi DH, Goodier DW, Ang SC. Impact of London's terrorist attacks on a major trauma center in London. *Prehosp Disaster Med* 2006; **21**: 340-4.
- Edgar DW, Wood F, Goodwin-Walters A. First response, rehabilitation, and outcomes of hand and upper limb function: survivors of the Bali bombing disaster. A case series report. *J Hand Ther* 2006; **19**: 283-97, quiz 298.
- Howe Jr HR, Poole Jr GV, Hansen KJ, Clark T, Plonk GW, Koman LA *et al*. Salvage of lower extremities following combined orthopedic and vascular trauma. A predictive salvage index. *Am Surg* 1987; **53**: 205-8.
- Helfet DL, Howey T, Sanders R, Johansen K. Limb salvage versus amputation. Preliminary results of the Mangled Extremity Severity Score. *Clin Orthop* 1990; **(256)**: 80-6.
- Johansen K, Daines M, Howey T, Helfet D, Hansen Jr ST. Objective criteria accurately predict amputation following lower extremity trauma. *J Trauma* 1990; **30**: 568-72, discussion 572-3.
- McNamara MG, Heckman JD, Corley FG. Severe open fractures of the lower extremity: a retrospective evaluation of the Mangled Extremity Severity Score (MESS). *J Orthop Trauma* 1994; **8**: 81-7.
- Gregory RT, Gould RJ, Peclet M, Wagner JS, Gilbert DA, Wheeler JR *et al*. The mangled extremity syndrome (M.E.S.): a severity grading system for multisystem injury of the extremity. *J Trauma* 1985; **25**: 1147-50.
- Ly TV, Trivison TG, Castillo RC, Bosse MJ, MacKenzie EJ, LEAP Study Group. Ability of lower-extremity injury severity scores to predict functional outcome after limb salvage. *J Bone Joint Surg Am* 2008; **90**: 1738-43.
- Brown KV, Ramasamy A, McLeod J, Stapley S, Clasper JC. Predicting the need for early amputation in ballistic mangled extremity injuries. *J Trauma* 2009; **66** (Suppl): S93-7, discussion S97-8.
- Bosse MJ, MacKenzie EJ, Kellam JF, Burgess AR, Webb LX, Swiontkowski MF *et al*. An analysis of outcomes of reconstruction or amputation after leg-threatening injuries. *N Engl J Med* 2002; **347**: 1924-31.
- Busse JW, Jacobs CL, Swiontkowski MF, Bosse MJ, Bhandari M, Evidence-Based Orthopaedic Trauma Working Group. Complex limb salvage or early amputation for severe lower-limb injury: a meta-analysis of observational studies. *J Orthop Trauma* 2007; **21**: 70-6.
- Bosse MJ, McCarthy ML, Jones AL, Webb LX, Sims SH, Sanders RW *et al*. The insensate foot following severe lower extremity trauma: an indication for amputation? *J Bone Joint Surg Am* 2005; **87**: 2601-8.
- The British Association of Plastic, Reconstructive and Aesthetic Surgeons. *Guidelines for Primary Amputation*. 2008 <<http://www.bapras.org.uk/downloadaddoc.asp?id=397>> [accessed 1 Feb. 2010].
- British Orthopaedic Association and The British Association of Plastic, Reconstructive and Aesthetic Surgeons. *The management of severe open lower limb fractures*. 2009 <<http://www.boa.ac.uk/en/publications/boast/>> [accessed 1 February 2010].
- Brooks A, Butcher W, Walsh M, Lambert A, Browne J, Ryan J. The experience and training of British general surgeons in trauma surgery for the abdomen, thorax and major vessels. *Ann R Coll Surg Engl* 2002; **84**: 409-13.
- Hamill J, Beasley SW. Training in paediatric trauma: the problem of safer soci-

- eties. *Aust NZ J Surg* 2006; **76**: 596–9.
36. Thomson BN, Civil ID, Danne PD, Deane SA, McGrath PJ. Trauma training in Australia and New Zealand: results of a survey of advanced surgical trainees. *Aust NZ J Surg* 2001; **71**: 83–8.
37. Bergeron E, Lavoie A, Belcaid A, Moore L, Clas D, Razek T *et al*. Surgical management of blunt thoracic and abdominal injuries in Quebec: a limited volume. *J Trauma* 2007; **62**: 1421–6.
38. Bulinski P, Bachulis B, Naylor Jr DF, Kam D, Carey M, Dean RE. The changing face of trauma management and its impact on surgical resident training. *J Trauma* 2003; **54**: 161–3.
39. Esposito TJ, Leon L, Jurkovich GJ. The shape of things to come: results from a national survey of trauma surgeons on issues concerning their future. *J Trauma* 2006; **60**: 8–16.
40. Fakhry SM, Watts DD, Michetti C, Hunt JP, EAST Multi-Institutional Blunt Hollow Viscous Injury Research Group. The resident experience on trauma: declining surgical opportunities and career incentives? Analysis of data from a large multi-institutional study. *J Trauma* 2003; **54**: 1–7, discussion 7–8.

Appendix 1: Layout of responses to questions

1. I would rate my confidence in decision making and practical application as:

- Not confident
- Satisfactory but lacking confidence
- Confident in some cases
- Fully confident

2. I would expect to see a case like this:

- Once a month
- Every 1–3 months
- Every 3–6 months
- Every 6 months to 1 year
- Once every 2 years
- Never been involved in such a case

3. My operative role for such a case would be:

- Assisting
- Supervised-trainer scrubbed
- Supervised-trainer un-scrubbed but in theatre
- Performing (lead surgeon)
- Training a more junior surgeon

4. I regard my training in the management of this case as:

- Adequate for my stage of training
- Inadequate for my stage of training