Cureus
Part of SPRINGER NATURE

Open Access Original Article

Awareness, Not Seniority, Is Associated With Change in Tourniquet Practice for Ankle Fracture Fixation: An International Cross-Sectional Survey

Review began 10/31/2026
Review ended 11/05/2026
Published 11/08/2026

© **Copyright** 2026
Hashem et al. This is an open access article distributed under the terms of the Creative Commons Attribution License CC-BY 4.0., which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

DOI: 10.7759/cureus.119305

Mohamed Hashem [1], Omar Taha [2], Ahmed Shalaan [3], Mohamed Elgamal [4], Mohamed A. Khalafallah [5], Ahmed Abdelkarim [6], Mohamed K. El-Mesery [7], Tamer Kamal [8], Nayeem Z. Hali [9], Somok Banerjee [10]

1. Orthopaedic Surgery, Royal Blackburn Teaching Hospital, East Lancashire Hospitals NHS Trust, Blackburn, GBR 2. Orthopaedics, Royal Shrewsbury Hospital, Shrewsbury, GBR 3. Trauma and Orthopaedics, Bedfordshire Hospitals NHS Foundation Trust, Bedford, GBR 4. Trauma and Orthopaedics, Royal Cornwall Hospitals NHS Trust, Truro, GBR 5. Faculty of Medicine, Alexandria University, Alexandria, EGY 6. Trauma and Orthopaedics, Alexandria University Hospitals, Alexandria, EGY 7. Trauma and Orthopaedics, Tanta University Hospital, Tanta, EGY 8. Trauma and Orthopaedics, Lewisham and Greenwich NHS Trust, London, GBR 9. Trauma and Orthopaedics, Worcestershire Acute Hospitals NHS Trust, Birmingham, GBR 10. Orthopaedics, All India Institute of Medical Sciences, Raipur, IND

Corresponding author: Mohamed Elgamal, mohammedelgaml9@gmail.com

Abstract

Introduction

Recent randomised evidence and the 2021 British Orthopaedic Association Standard for Trauma (BOAST) have questioned routine, unselective tourniquet use. This study aimed to describe tourniquet practice in ankle fracture fixation and identify factors associated with evidence- and guideline-concordant practice.

Methodology

An international cross-sectional online survey of orthopaedic surgeons who perform ankle fracture fixation was distributed through the OrthoXcel Collaborator Network between 10 May and 4 June 2026. It covered tourniquet practice, awareness of recent evidence and of BOAST, local policy and willingness to change. Associations were tested with χ^2, Fisher's exact and trend tests and logistic regression.

Results

In all, 85 surgeons from four countries responded (United Kingdom 45, Egypt 29, India 6, UAE 5; 26 consultants, 26 specialty doctors and 33 trainees). Overall, 75/85 (88.2%) used a tourniquet routinely, with no difference by grade (p = 0.677). Only 17/85 (20.0%) were fully aware of recent randomised evidence and 44/85 (51.8%) of BOAST, and 11/85 (12.9%) reported a local policy. Of routine users, 58/75 (77.3%) used a fixed pressure rather than one individualised to systolic blood pressure. Reported practice change rose from 13.9% among surgeons unaware of the evidence to 58.8% among those fully aware (adjusted odds ratio (OR) 10.1; 95% confidence interval (CI) 2.4-42.4), and BOAST application rose from 13.6% to 85.0% with BOAST awareness (adjusted OR 33.6; 95% CI 5.3-214.0). Grade, experience and country were not independently associated with either outcome. BOAST appliers more often individualised pressure ((14/42, 33.3% vs. 3/33, 9.1%; $P = 0.014$). Most routine users (66/75, 88.0%) were open to change.

Conclusions

Routine thigh tourniquet use at a fixed pressure remains the norm in ankle fracture fixation, with little institutional governance. Awareness, rather than seniority, was associated with change. Targeted dissemination of the evidence and BOAST, supported by local policies, is a practical lever while definitive trials are awaited.

Categories: Trauma, Sports Medicine, Orthopedics
Keywords: complications, foot & ankle surgery, guidlines, surgery, tourniquet

Introduction

Ankle fractures are among the most common fractures managed by orthopaedic surgeons, and open reduction and internal fixation (ORIF) is one of the most frequently performed trauma procedures [1]. A pneumatic thigh tourniquet is widely used during ankle ORIF to provide a bloodless field, improve visualisation of the fracture and shorten operating time [2,3].

Tourniquets are not without harm. Recognised complications include thigh pain, nerve injury, skin and pressure injury, postoperative swelling, wound complications and the systemic effects of ischaemia-reperfusion, and their risk rises with excessive pressure and prolonged inflation [2-5]. In knee arthroplasty, a Cochrane review found that routine tourniquet use was associated with more serious adverse events and

greater postoperative pain, with shorter operating time as the only clear benefit [6,7]. In ankle fracture surgery, randomised trials have reported greater early postoperative pain and swelling with tourniquet use [8,9], and a meta-analysis of randomised trials in lower limb trauma could not exclude an increase in harm [10]. A 2022 meta-analysis specific to ankle ORIF found that tourniquet use shortened surgery but was associated with higher early postoperative pain and reduced range of movement at six weeks, without a significant difference in wound infection or venous thromboembolism [11]. These data establish clinical equipoise rather than a mandate to abandon tourniquets, but they challenge their routine, unselective use.

In October 2021, the British Orthopaedic Association published its Standards for Trauma (BOAST) on the safe use of intraoperative tourniquets [12]. It recommends that tourniquets are used only when clinically justified; that, in adults, lower limb inflation pressure is set at the patient's systolic blood pressure (SBP) plus 70-130 mmHg; that ischaemic time should ideally be less than 120 minutes, with extension only after clinical reassessment, audible reminders every 10 minutes thereafter and use beyond 150 minutes rarely justified; and that the tourniquet type, pressure, duration, exsanguination method and condition of the tourniquet site are documented. Whether this guidance and the accompanying evidence have changed practice is unknown, particularly outside the United Kingdom and across professional grades.

The aims of this international survey were to describe current tourniquet practice in ankle fracture fixation, to quantify awareness of the recent evidence and of BOAST, and to identify the factors associated with practice change and guideline application. We hypothesised that awareness, rather than seniority, would be the main determinant of evidence-concordant practice.

Materials And Methods

Study design and reporting

This was an international, cross-sectional, self-administered online survey reported in accordance with the Consensus-Based Checklist for Reporting of Survey Studies (CROSS) and the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) [13,14].

Questionnaire

The questionnaire was developed by the OrthoXcel Collaborator Network steering group from the BOAST standard [12] and the published literature [7,10,11]. It was hosted on Google Forms and comprised five domains: respondent characteristics (grade, subspecialty, country, institution, years of experience and annual ankle fracture fixation volume); awareness of BOAST and of the recent randomised and meta-analytic evidence (with links to the key publications); tourniquet practice (frequency, type, site, pressure, maximum duration, rationale, perceived benefits and patient-reported symptoms attributed to the tourniquet); local governance (existence of and adherence to a local policy); and attitudes (practice change, openness to change, drivers of change and Likert-scale ratings of the applicability, practicality and consistency of BOAST). Branching logic directed surgeons who did not use a tourniquet routinely to a separate set of questions on their reasons, alternatives and observed outcomes. The full questionnaire is provided in the Appendix.

Participants and distribution

Orthopaedic surgeons of any grade who perform or supervise ankle fracture fixation were eligible. The Google Forms survey link was distributed by official email from the OrthoXcel Collaborator Network to its members, who were invited to share it with colleagues, and the survey was open from 10 May to 4 June 2026. Participation was voluntary and unincentivised. The opening section of the form described the purpose of the study and how data would be used, and respondents gave electronic informed consent before proceeding. Email addresses were collected only to prevent duplicate entries and were removed before analysis. Because the survey was disseminated through open networks, the number of surgeons who received the invitation, and therefore the response rate, could not be determined.

Ethics

Formal research ethics committee approval was not sought because this was a voluntary survey of healthcare professionals about their own professional practice, with no patient involvement and no patient data. All participants gave informed consent electronically within the survey. Personal data were processed in accordance with the UK General Data Protection Regulation, and the OrthoXcel Collaborator Network is registered with the UK Information Commissioner's Office (registration number ZC007587).

Definitions

Grade was grouped as consultant, specialty/staff grade and associate specialist (SAS) doctor, or trainee (all registrar grades, residents and clinical fellows). Country was coded from free-text responses. Routine use was defined as tourniquet use in more than 70% of ankle fracture fixations. Individualised pressure was defined as selecting "variable, per systolic blood pressure or other patient factors"; all fixed pressure bands were classed as non-individualised. Any practice change combined responses of "yes" and "to some extent".

Free-text responses on comorbidities were coded as "modifies use" (avoids, minimises, or lowers pressure or duration), "no influence" or "unclear"; other free-text comments were analysed thematically.

Statistical analysis

Categorical data are presented as counts and percentages with Wilson 95% CIs [15]. Groups were compared using the χ^2 test or Fisher's exact test where expected cell counts were below five, with Cramér's V as the effect size; ordinal exposures were assessed with the linear-by-linear (trend) test. The primary analysis examined the association between awareness of the recent evidence and any reported practice change in all respondents. The secondary analysis examined the association between BOAST awareness and self-reported regular BOAST application among routine users. Each was tested in a multivariable logistic regression model adjusted for country (United Kingdom vs non-United Kingdom) and years of experience (ordinal); a sensitivity model replaced experience with grade. Results are reported as adjusted ORs with 95% CIs. Likert ratings were summarised as medians and interquartile ranges (IQRs); three non-numeric ("yes") entries were excluded. Analyses were performed in Python 3 (SciPy and statsmodels), and a two-sided $P < 0.05$ was considered significant.

Results

Respondents

A total of 85 complete responses were received from surgeons working at more than 35 hospitals in four countries (Table *1*). Most respondents practised in the United Kingdom (45, 52.9%) or Egypt (29, 34.1%). There were 26 consultants (30.6%), 26 specialty/SAS doctors (30.6%) and 33 trainees (38.8%); 14 (16.5%) were foot and ankle specialists. Most respondents (61, 71.8%) performed 11 to 50 ankle fracture fixations per year.

Characteristic	*n* (%)
Grade	
Consultant	26 (30.6)
Specialty/SAS doctor	26 (30.6)
Trainee (registrar, resident or fellow)	33 (38.8)
Country of practice	
United Kingdom	45 (52.9)
Egypt	29 (34.1)
India	6 (7.1)
United Arab Emirates	5 (5.9)
Subspecialty	
General orthopaedics (including trainees)	41 (48.2)
Trauma	19 (22.4)
Foot and ankle	14 (16.5)
Other	11 (12.9)
Experience in orthopaedic surgery, years	
<5	25 (29.4)
5-10	13 (15.3)
11-15	21 (24.7)
16-20	12 (14.1)
>20	14 (16.5)
Ankle fracture fixations per year	
0-10	13 (15.3)
11-25	33 (38.8)
26-50	28 (32.9)
51-75	6 (7.1)
>75	5 (5.9)

TABLE 1: Characteristics of the 85 respondents.

SAS, specialty/staff grade and associate specialist

Current tourniquet practice

Overall, 75/85 (88.2%; 95% CI 79.7-93.5) respondents used a tourniquet routinely, with no difference between consultants (24/26, 92.3%), SAS doctors (23/26, 88.5%) and trainees (28/33, 84.8%; $P = 0.677$; Table 2). All routine users (75/75, 100%) applied the tourniquet to the thigh, and 71/75 (94.7%) used a pneumatic device. The most frequently cited benefits were improved visualisation (69/75, 92.0%), shorter operating time (58/75, 77.3%) and reduced bleeding (56/75, 74.7%); surgeon preference (35/75, 46.7%) and facilitating trainee involvement (17/75, 22.7%) were also common. Only 21/85 (24.7%) respondents reported that their use varied with fracture pattern.

Variable	Consultant (*n* = 26)	SAS (*n* = 26)	Trainee (*n* = 33)	Total (*n* = 85)	χ^2 (df)	*P*-value
All respondents						
Fully aware of BOAST	16 (61.5)	15 (57.7)	13 (39.4)	44 (51.8)	8.01 (4)	0.091
Fully aware of recent evidence	6 (23.1)	6 (23.1)	5 (15.2)	17 (20.0)	1.14 (4)	0.888
Any practice change	7 (26.9)	13 (50.0)	11 (33.3)	31 (36.5)	7.63 (4)	0.106
Local hospital policy present	1 (3.8)	7 (26.9)	3 (9.1)	11 (12.9)	10.67 (4)	0.031
Use varies with fracture pattern	7 (26.9)	4 (15.4)	10 (30.3)	21 (24.7)	1.84 (2)	0.399
Comorbidities modify use†	16 (61.5)	12 (46.2)	12 (36.4)	40 (47.1)	5.12 (4)	0.275
Routine tourniquet use (> 70%)	24 (92.3)	23 (88.5)	28 (84.8)	75 (88.2)	0.78 (2)	0.677
Routine users only						
n	24	23	28	75		
Individualised (SBP-based) pressure	3 (12.5)	7 (30.4)	7 (25.0)	17 (22.7)	2.29 (2)	0.318
Fixed pressure ≥ 350 mmHg	0 (0)	1 (4.3)	4 (14.3)	5 (6.7)	10.38 (8)	0.239‡
Maximum duration ≤ 120 min	23 (95.8)	22 (95.7)	28 (100)	73 (97.3)	-	-
Patient symptoms attributed to tourniquet	6 (25.0)	7 (30.4)	5 (17.9)	18 (24.0)	3.03 (4)	0.552
Regularly applies BOAST	15 (62.5)	13 (56.5)	14 (50.0)	42 (56.0)	0.82 (2)	0.663
Open to changing practice	20 (83.3)	19 (82.6)	27 (96.4)	66 (88.0)	3.01 (2)	0.222

TABLE 2: Awareness, governance and tourniquet practice by professional grade.

Data are *n* (%) unless stated. *P*-values are from the Pearson χ^2 test of the association between professional grade and each item, across all response categories of that item; the χ^2 statistic (degrees of freedom, df) is shown beside the *P*-value.

†Coded from free text (avoids, minimises, or lowers pressure or duration).

‡Test across all five pressure categories.

BOAST, British Orthopaedic Association Standard for Trauma; SAS, specialty and associate specialist; SBP, systolic blood pressure

Among routine users, only 17/75 (22.7%; 95% CI 14.7-33.3) individualised pressure according to SBP or other patient factors. The remainder used a fixed pressure: 250-299 mmHg in 37/75 (49.3%), 300-349 mmHg in 10/75 (13.3%), <250 mmHg in 6/75 (8.0%) and ⩾350 mmHg in 5/75 (6.7%). For context, BOAST implies a range of 190-250 mmHg for a patient with an SBP of 120 mmHg; the 15/75 (20.0%) routine users who typically used ⩾300 mmHg would exceed the recommended range unless SBP were at least 170 mmHg. In contrast, duration was largely concordant with BOAST: 73/75 (97.3%) usually allowed a maximum of 120 minutes or less. Comorbidities such as diabetes, peripheral arterial disease and chronic kidney disease led 40/85 (47.1%) respondents to avoid or modify tourniquet use, most often citing vascular disease (23/40, 57.5%), whereas 28/85 (32.9%) reported no influence and 17/85 (20.0%) gave an unclear answer.

Of routine users, 18/75 (24.0%) reported that patients had experienced symptoms they attributed to the tourniquet, and 14/75 (18.7%) were unsure. Thigh pain was the most frequently reported (15/18, 83.3%), followed by nerve injury (5/18, 27.8%) and swelling (3/18, 16.7%).

Awareness and governance

Only 17/85 (20.0%; 95% CI 12.9-29.7) respondents were fully aware of the recent randomised and meta-analytic evidence, 32/85 (37.6%) were partially aware and 36/85 (42.4%) were unaware. Full awareness of BOAST was reported by 44/85 (51.8%; 95% CI 41.3-62.1). Neither form of awareness differed significantly by grade (Table 2). Only 11/85 (12.9%; 95% CI 7.4-21.7) respondents reported that their hospital had a local tourniquet policy, 57/85 (67.1%) reported none and 17/85 (20.0%) were unsure; of the 11 with a policy, 4/11 (36.4%) did not follow it consistently. Reporting of a local policy differed by grade (consultants 3.8%, SAS doctors 26.9%, trainees 9.1%; $P = 0.031$).

Awareness, not seniority, is associated with practice change

Overall, 31/85 (36.5%) respondents reported having changed their practice at least to some extent. Reported change increased stepwise with awareness of the evidence, from 5/36 (13.9%) in those who were unaware to 16/32 (50.0%) in those partially aware and 10/17 (58.8%) in those fully aware ($\chi^2(2) = 14.12$, $P < 0.001$; trend $P < 0.001$; Cramér's V = 0.41; Figure *1A*). After adjustment for country and experience, partial (OR 6.79; 95% CI 2.02-22.87) and full awareness (OR 10.06; 95% CI 2.38-42.44) remained independently associated with change, whereas practice in the United Kingdom (OR 0.94; 95% CI 0.32-2.76) and experience (OR 0.90 per category; 95% CI 0.63-1.29) were not (Table *3*). Substituting grade for experience did not alter these findings, and grade itself was not associated with change.

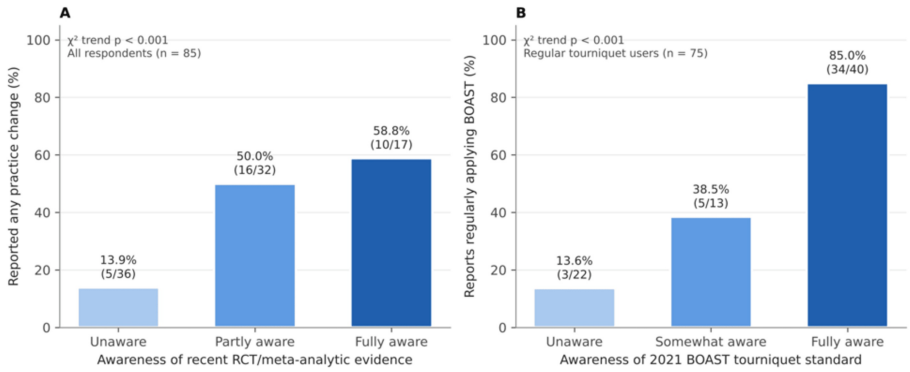


FIGURE 1: Practice change and BOAST application according to awareness.

(A) Evidence awareness and practice change: Proportion of all respondents (*n* = 85) reporting any change in tourniquet practice according to awareness of the recent randomised and meta-analytic evidence. (B) BOAST awareness and BOAST application: Proportion of routine tourniquet users (*n* = 75) who regularly applied the 2021 British Orthopaedic Association Standard for Trauma (BOAST) according to awareness of the standard. Labels show percentages and *n*/*N*; *P* values are from the linear-by-linear trend test.

RCT, randomised controlled trial

Variable	Adjusted OR (95% CI)	*P*-value
Model 1: any practice change (all respondents, *n* = 85)		
Awareness of recent evidence: none	Reference	-
Awareness of recent evidence: partial	6.79 (2.02-22.87)	0.002
Awareness of recent evidence: full	10.06 (2.38-42.44)	0.002
UK practice (vs non-UK)	0.94 (0.32-2.76)	0.913
Years of experience (per category)	0.90 (0.63-1.29)	0.555
Model 2: regular BOAST application (routine users, n = 75)		
BOAST awareness: none	Reference	-
BOAST awareness: somewhat	4.38 (0.74-26.08)	0.105
BOAST awareness: full	33.62 (5.28-214.01)	<0.001
UK practice (vs non-UK)	1.73 (0.37-8.12)	0.490
Years of experience (per category)	0.80 (0.49-1.30)	0.370

TABLE 3: Multivariable logistic regression models for reported practice change and regular BOAST application.

Experience was entered as an ordinal variable (<5, 5-10, 11-15, 16-20, >20 years). In a sensitivity analysis replacing experience with grade, the ORs for partial and full evidence awareness were 6.78 (95% CI 2.00-22.94) and 10.08 (95% CI 2.35-43.22), respectively; neither consultant nor SAS grade was associated with change.

BOAST, British Orthopaedic Association Standard for Trauma; CI, confidence interval; OR, odds ratio; SAS, specialty/staff grade and associate specialist

Similarly, among routine users, regular application of BOAST rose from 3/22 (13.6%) in those unaware of the standard to 5/13 (38.5%) in those somewhat aware and 34/40 (85.0%) in those fully aware ($\chi^2(2) = 31.30$, $P < 0.001$; Cramér's V = 0.65; Figure *1B*). Full awareness remained strongly associated with application after adjustment (OR 33.62; 95% CI 5.28-214.01), whereas country and experience were not (Table *3*).

Guideline application was in turn associated with safer pressure selection (Figure *2*). Surgeons who applied BOAST individualised pressure more often than those who did not (14/42, 33.3% vs. 3/33, 9.1%; OR 5.0; $P = 0.014$, Fisher's exact test), and all five respondents using ≥350 mmHg were non-appliers (0/42 vs. 5/33; $P = 0.014$).

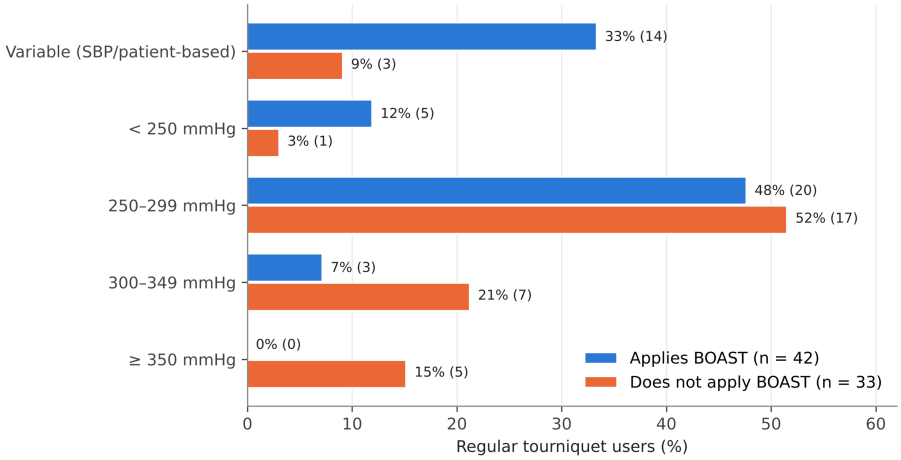


FIGURE 2: Typical tourniquet pressure among routine users according to BOAST application.

Routine tourniquet users, *n* = 75 (42 applying BOAST, 33 not applying BOAST). Individualised pressure was more common among BOAST appliers (33.3% vs. 9.1%; *P* = 0.014, Fisher's exact test), and pressures ≥350 mmHg were reported only by non-appliers.

BOAST, British Orthopaedic Association Standard for Trauma; SBP, systolic blood pressure

Country

Respondents from the United Kingdom were more often fully aware of BOAST (35/45, 77.8% vs. 9/40, 22.5%; *P* < 0.001) and of the evidence (13/45, 28.9% vs. 4/40, 10.0%; *P* = 0.034), and more often applied BOAST (33/44, 75.0% vs. 9/31, 29.0%; *P* < 0.001). Paradoxically, they were also more likely to use a tourniquet routinely (44/45, 97.8% vs. 31/40, 77.5%; *P* = 0.005) and were no more likely to report practice change (18/45, 40.0% vs. 13/40, 32.5%; *P* = 0.473).

Surgeons who do not use a tourniquet routinely

Ten/85 (11.8%) respondents did not use a tourniquet routinely, eight of whom practised in Egypt; six had previously done so and changed mainly because of awareness of the evidence. Their main reasons were avoiding postoperative pain (7/10, 70.0%), concern about soft-tissue complications (6/10, 60.0%) and adequate visualisation without a tourniquet (6/10, 60.0%). Only one (1/10, 10.0%) used an alternative such as local anaesthetic with adrenaline. Nine/10 (90.0%) reported no increase in postoperative complications, although three/10 (30.0%) noted longer operating time or greater blood loss, and seven/10 (70.0%) perceived improved postoperative recovery, mainly less pain and swelling.

Readiness to change and views on BOAST

Most routine users (66/75, 88.0%; 95% CI 78.7-93.6) were open to changing their practice. The most frequently selected drivers were awareness of existing high-quality evidence (58/66, 87.9%), national guidelines (39/66, 59.1%) and a robust prospective trial (30/66, 45.5%), ahead of a validated alternative (17/66, 25.8%) and local policy (15/66, 22.7%). BOAST was rated favourably for applicability, practicality and consistency of implementation (median 4/5 for each: applicability IQR 3-4, practicality IQR 3-5, consistency IQR 3-4.5; 64.1%, 71.8% and 69.2% rated ⩾4, respectively; n = 39). Free-text comments identified recurring themes: documentation that was perceived as burdensome or duplicative yet medicolegally important; a need for clearer practical guidance on pressure setting; explicit recommendations for high-risk patients (diabetes, peripheral arterial disease, neuropathy and poor skin); guidance on selective rather than routine use; and a call for a shorter, simpler version of the standard.

Discussion

This international survey shows that routine thigh tourniquet use remains the norm in ankle fracture fixation, reported by almost nine in ten surgeons at every grade, and that most routine users apply a fixed rather than an individualised pressure. Only one in five surgeons was fully aware of the recent randomised evidence and one in eight reported a local policy. The central finding is that awareness, and not seniority, experience or country, was independently associated with change: surgeons who knew the evidence were around ten times more likely to report having changed their practice, and those who knew BOAST were more than 30 times more likely to apply it, which in turn was associated with safer pressure selection.

These findings illustrate a classic evidence-to-practice gap [16-18]. Seniority did not protect against it: consultants were no more aware of the evidence than trainees and were the least likely to report a local policy. The gap therefore appears to reflect the dissemination of evidence rather than clinical experience, which is encouraging because dissemination is modifiable. Respondents agreed: awareness of high-quality evidence was by far the most frequently selected driver of change, ahead of local policy. Practical levers include incorporating BOAST into trainee curricula and departmental teaching, short evidence summaries in trauma meetings, and audit of tourniquet use against the standard.

The United Kingdom findings add an important nuance. Surgeons from the United Kingdom were much more aware of BOAST and more likely to apply it, yet were more likely to use a tourniquet routinely and no more likely to report change. This is consistent with the nature of the standard: BOAST is a safe-use standard that governs how a tourniquet is used (pressure, time and documentation) rather than whether it should be used. Guideline awareness may therefore improve the safety of tourniquet use without reducing its frequency; changing the decision to use a tourniquet at all will probably require stronger comparative evidence specific to ankle fractures, which respondents themselves requested.

Pressure selection was the clearest safety signal. More than three-quarters of routine users set a fixed pressure, and five used ⩾350 mmHg. For a normotensive patient (SBP 120 mmHg), BOAST implies 190-250 mmHg, so the most common fixed setting of 250-299 mmHg sits at or above the upper end of the recommended range, and settings of 300 mmHg or more exceed it unless the patient is hypertensive. Because individual SBP was not recorded, fixed pressures cannot be classed as non-compliant, but they do not account for patient variation and are likely to be higher than necessary in many patients. Lower, individualised pressures based on SBP or limb occlusion pressure provide an effective bloodless field [19], and excessive pressure and duration are associated with complications [4,20]. The association between BOAST application and individualisation, and the absence of BOAST appliers using ⩾350 mmHg, suggest that guideline uptake translates into safer behaviour. By contrast, duration was reassuringly concordant with the standard in almost all respondents.

Governance was weak. Only 12.9% of respondents reported a local policy, 20.0% did not know whether one existed, and over a third of those with a policy did not follow it consistently. The higher rate of policy reporting by SAS doctors than by consultants may reflect differences in awareness rather than in the existence of policies, as respondents from the same hospital did not always agree. A simple local policy aligned with BOAST, embedded in the WHO surgical safety checklist and supported by audit, is a low-cost intervention that could standardise pressure setting and documentation.

The small group of surgeons who no longer use a tourniquet routinely reported no increase in complications and perceived better early recovery, consistent with randomised data showing less early pain and swelling without a tourniquet [8,9,11]. However, some noted longer operating time or greater blood loss, and these self-selected observations cannot establish comparative safety or effectiveness. Taken together with the reported benefits of a bloodless field, the data support equipoise and a selective, justified approach, as advocated by BOAST [12], rather than universal abandonment. An adequately powered multicentre randomised trial with patient-reported outcomes is needed to settle the question.

Limitations

Strengths of this study include respondent-level data from surgeons of all grades in four countries, prespecified definitions, the linkage of awareness to behaviour within individuals, and adjustment for country and experience. Several limitations apply. Convenience sampling through a collaborative network means that the response rate is unknown, and the sample is concentrated in the United Kingdom and Egypt, so the results may not be generalisable. Practice was self-reported and may be subject to social desirability and recall bias. The cross-sectional design cannot establish causality: surgeons who had changed practice may have subsequently sought out the evidence, and the question itself presented the evidence to respondents. Confidence intervals for the adjusted ORs were wide because of the sample size, although the direction and magnitude were consistent across analyses. Some items were free text or multiple choice and required coding. Finally, we could not verify complication rates, actual pressures in relation to patient SBP, or cuff characteristics, so the reported symptoms should not be interpreted as complication rates.

Conclusions

Routine thigh tourniquet use at a fixed pressure remains the dominant practice in ankle fracture fixation internationally, with limited awareness of the recent evidence and little local governance. Awareness of the evidence and of BOAST, rather than seniority, was associated with practice change and guideline application, and surgeons are receptive to change. Targeted dissemination of the evidence and the standard, simple local policies with individualised pressure setting, and a definitive randomised trial are the logical next steps.

Appendices

Appendix : Survey questionnaire

No.	Question	Response (type and options)
Q1	Email *	Short answer
	Section 2: General information about your tourniquet practice in ankle fracture fixation	
Q2	What is your current professional grade? *	Single choice
		Consultant (Working independently at Consultant level)
		Specialty Doctor / SAS Doctor
		ST7–8 (Senior Registrar)
		ST3–6 (Registrar)
		Other (free text)
Q3	Your subspecialty? *	Single choice
		Foot and Ankle Surgeon
		Trauma Surgeon
		General Orthopaedics (Including trainee and Registrars)
		Other (free text)
Q4	Country and City *	Short answer
Q5	Institution/Hospital *	Short answer
Q6	How many years of experience do you have in orthopaedic surgery? *	Single choice (drop-down)
		< 5 years
		5–10 years
		11–15 years
		16–20 years
		> 20 years
Q7	Approximately how many ankle fracture fixation procedures do you perform per year? *	Single choice (drop-down)
		0–10
		11–25
		26–50
		51–75
		> 75
Q8	Are you aware of the new BOAST guidelines about safe use of intraoperative tourniquet, 2021? *	Single choice
		Yes
		No
		Somewhat Aware
Q9	Are you aware of the recent high quality evidence debating benefits of regular use of Tourniquet in lower limb trauma surgery and highlighting the associated higher rate of complications including but not only: https://www.jfas.org/article/S1067-2516(22)00019-9/fulltext; https://pubmed.ncbi.nlm.nih.gov/33792771/;	Single choice

	https://pubmed.ncbi.nlm.nih.gov/33934656 *	
		Yes
		No
		Some of them
Q10	Have you changed your practice based on this guidelines or evidence? *	Single choice
		Yes
		No
		To some extent
Q11	If the answer is YES, How and Why? *	Long answer
Q12	Does your hospital have a local policy on tourniquet use in ankle fracture fixation? *	Single choice (drop-down)
		Yes
		No
		Not sure
Q13	If your hospital have a local policy on tourniquet use in ankle fracture fixation, do you follow it in your clinical practice? *	Single choice (drop-down)
		Yes, consistently
		Yes, but not consistently
		No
		Not applicable / no local policy
Q14	What are the main points of this local policy if it exists?	Short answer
Q15	Does your use of tourniquet vary according to fracture pattern? *	Single choice
		Yes
		No
Q16	If YES, How your tourniquet use varies according to fracture type (Bimalleolar/Trimalleolar/Open etc) *	Short answer
Q17	How patient comorbidities (diabetes, PAD, CKD) influence your tourniquet use decisions? *	Short answer
Q18	Do you regularly (>70%) use tourniquet in fixation of ankle fractures? *	Single choice
		Yes (go to Section 3)
		No (go to Section 4)
	Section 3: Tourniquet users. If you use tourniquet in ankle fracture fixation regularly. On completion, respondents continued to Section 5.	
Q19	What type of tourniquet do you use? *	Single choice
		Pneumatic Tourniquets
		Non-Pneumatic (Non-Inflatable) Tourniquets (Esmarch Bandage, Elastic/Silicone Rings)
		Other (free text)
Q20	What tourniquet position do you use for your ankle fracture fixation?	Single choice
		Thigh tourniquet
		Calf Tourniquet
	What is your rationale behind using tourniquet in fixation of ankle fractures? Please describe all the	

Q21	rationales *	Long answer
Q22	What are your main benefits from using a tourniquet in ankle fracture fixation? (Select all that apply) *	Multiple choice (select all that apply)
		Improved visualisation
		Shorter operative time
		Reduced intraoperative bleeding
		Trainee involvement / facilitating teaching
		Surgeon preference
		Local unit policy
		Not applicable (do not use tourniquet)
		Other (free text)
Q23	Have patients reported any complaints or symptoms that you believe may be related to tourniquet use in ankle fracture fixation (e.g., thigh pain, neuropraxia, swelling)? *	Single choice (drop-down)
		Yes
		No
		Unsure
Q24	If YES, what are these complications/adverse effects? (Select all that apply) *	Multiple choice (select all that apply)
		Thigh pain
		Wound issues
		Hematoma
		Nerve Injury
		Burn
		Swelling
		Compartment Syndrome
		Skin changes
		None of these
Q25	What pressure do you typically apply? *	Single choice (drop-down)
		< 250 mmHg
		250–299 mmHg
		300–349 mmHg
		≥ 350 mmHg
		Variable (Per Systolic Blood Pressure/Other Patient Factors)
		Not applicable (do not use a tourniquet)
Q26	What is the maximum duration you usually allow for tourniquet inflation during ankle fracture fixation? *	Single choice (drop-down)
		< 60 minutes

		60–120 minutes
		120 min
		> 120 minutes
		Variable (depends on patient factors)
		Not applicable
Q27	Are you open to change your practice regarding tourniquet use? *	Single choice
		Yes
		No
Q28	If YES, What can encourage you to change your practice? *	Multiple choice (select all that apply)
		Awareness of existing high quality evidence
		Robust quality prospective clinical trial with consistent results
		Trial of alternative like (Local with adrenaline) with equivalent benefits
		National guidelines (NICE/BOAST)
		Local Policy
		Other (free text)
	Section 4: Non-tourniquet users. If you do not use tourniquet regularly in ankle fracture fixation. On completion, respondents continued to Section 7.	
Q29	Why do not you use the tourniquet in fixation of ankle fractures? *	Long answer
Q30	Do you use any alternatives for the tourniquet in fixation of ankle fracture like local anesthetic with adrenaline? *	Single choice
		Yes
		No
Q31	Did you use to use the tourniquet before in fixation of ankle fractures? *	Single choice
		Yes
		No
Q32	If YES, Why did you change your practice? *	Multiple choice (select all that apply)
		Awareness of the new high quality evidence
		Using alternative like local anaesthetic with adrenaline
		Local Policy
		Senior advice or recommendation
		Other (free text)
Q33	What is your rationale for not using a tourniquet in fixation of ankle fractures? (Select all that apply) *	Multiple choice (select all that apply)

		Concern about soft-tissue complications
		Adequate visualisation obtained without tourniquet
		Avoiding postoperative pain
		Avoiding physiological stress in medically frail patients
		Local unit policy
		Other (free text)
Q34	Have you noticed any increase in your postoperative complications after stopping tourniquet use? *	Single choice
		Yes
		No
		To some extent
Q35	If YES, what were the increased complications? Select all applies *	Multiple choice (select all that apply)
		Hematoma and wound problems
		Increase operative time
		Poor reduction or fixation
		Lower PROMs
		Increase intraoperative blood loss
		None (No increase in my postoperative complications)
Q36	Have you noticed any improvement in your patients' postoperative recovery with no use of tourniquet? *	Single choice
		Yes
		No
		To some extent
Q37	What benefits did you notice from not using tourniquet? *	Multiple choice (select all that apply)
		Less postop pain
		Quicker recovery
		Less thigh pain
		Better anaesthesia cover
		Less swelling
		Shorter hospital recovery
		None (No benefits noticed)
		Other (free text)
Q38	Feel free to add any comment	Long answer

	Section 5: BOAST guidelines practice. 2021 BOAST guidelines about The Safe Use Of Intraoperative Tourniquets practice.	
Q39	Do you regularly apply 2021 BOAST guidelines about The Safe Use Of Intraoperative Tourniquets in your practice? *	Single choice
		Yes (go to Section 6)
		No (go to Section 7)
	Section 6: BOAST guidelines validity. 2021 BOAST guidelines about The Safe Use Of Intraoperative Tourniquets validation.	
Q40	How applicable do you find the 2021 British Orthopaedic Association BOAST guidance titled “The Safe Use of Intraoperative Tourniquets” to routine ankle fracture fixation practice in your clinical setting? *	Linear scale
		1 (Not Applicable at all)
		2
		3
		4
		5 (Extremely Applicable)
Q41	Please state why?	Long answer
Q42	To what extent do you feel the recommendations within the 2021 BOAST guidance titled “The Safe Use of Intraoperative Tourniquets” are practical and dependable in day-to-day orthopaedic trauma practice? *	Linear scale
		1 (Strongly Disagree)
		2
		3
		4
		5 (Strongly Agree)
Q43	Please state why?	Long answer
Q44	In your experience, how consistently can the recommendations of the 2021 BOAST guidance titled “The Safe Use of Intraoperative Tourniquets” be implemented across different surgeons, institutions, or healthcare settings? *	Linear scale
		1 (Strongly Disagree)
		2
		3
		4
		5 (Strongly Agree)
Q45	Please state why?	Long answer
Q46	If you answered any of these question with YES, What part of the guidelines needs update and what changes/updates to the 2021 BOAST titled “The Safe Use Of Intraoperative Tourniquets” you suggest to be more valid, reliable and reproducible? *	Long answer
	Section 7: Free comment	
Q47	Do you have any comments to add? *	Long answer

TABLE 4: Survey of tourniquet practice in ankle fracture fixation (Google Forms).

Section 1: Introduction and consent. Respondents read the introductory statement above and entered an email address (collected only to prevent duplicate responses); this section is not itemized below, and the questionnaire proper starts at Q1 (email).

* Required question (respondents could not proceed without answering). Questions without an asterisk were optional. BOAST, British Orthopaedic Association Standard for Trauma; SAS, specialty and associate specialist.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Acquisition, analysis, or interpretation of data: Mohamed Elgamal, Mohamed Hashem, Omar Taha, Ahmed Shalaan

Drafting of the manuscript: Mohamed Elgamal, Mohamed Hashem, Omar Taha, Ahmed Shalaan

Concept and design: Mohamed Hashem, Mohamed A. Khalafallah , Ahmed Abdelkarim, Mohamed K. El-Mesery, Tamer Kamal, Nayeem Z. Hali, Somok Banerjee

Critical review of the manuscript for important intellectual content: Mohamed Hashem, Mohamed A. Khalafallah , Ahmed Abdelkarim, Mohamed K. El-Mesery, Tamer Kamal, Nayeem Z. Hali, Somok Banerjee

Supervision: Mohamed Hashem

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

Acknowledgements

The authors wish to express their sincere gratitude to the OrthoXcel Collaborative Network, and in particular to its regional and local leads, whose dedication made this work possible. Often alongside demanding clinical workloads, these individuals coordinated collaborators, circulated the survey, encouraged participation and supported data collection in their regions. Their contribution was invaluable. The authors are especially grateful to the regional leads: Mr Ahmed Hassan, Mr Ahmed Eldesoki, Mr Hatem Salem, Mr Yassar Nassif, Mr Ahmed Atwa, Mr Mohammed Kabeel, Mr Hatem Hussein, Mr Kerollos Khilla and Dr Somok Banerjee. The authors also thank the local team members: Mr Mina Seifo, Mr Mohamed Omar Ahmed, Mr Hassan Mohsen, Mr Mohamed Mahmoud, Mr Ayobami Asaju, Dr Islam Saeed Youssef, Mr Amro Ghoraba, Dr Ahmed Elshafey, Mr Tarek Hassanin, Dr Ahmed Zobaa, Dr Ahmed Ebrahim Elhamaky, Mahmoud Mahdy Mahmoud, Mahmoud Abdullah, Dr Ahmed Ashraf Mohamed, Dr Omar Abdelaziz, Dr Ziad Gaber Zayed Abdelaziz Nagy, Dr Mohamed Khaled, Dr Ahmed Youssef Hassan, Mr Mohamed Kabary Mahmoud, Mr Srinivasan Gangadharan, Mr Moustafa Ahmad and Mr Annis Maatough. Their enthusiasm, professionalism and collaborative spirit demonstrate the strength of a trainee-led, multicentre network. This work would not have been possible without their contributions. AI tools (ChatGPT, OpenAI, San Francisco, CA; Claude, Anthropic, San Francisco, CA) were used during manuscript preparation to improve the language. All AI-assisted modifications were reviewed by a senior author, who takes responsibility for the final text.

References

1. Court-Brown CM, Caesar B: Epidemiology of adult fractures: a review . Injury. 2006, 37:691-7. 10.1016/j.injury.2006.04.130
2. Noordin S, McEwen JA, Kragh JF Jr, Eisen A, Masri BA: Surgical tourniquets in orthopaedics. J Bone Joint Surg Am. 2009, 91:2958-67. 10.2106/JBJS.I.00634
3. Fitzgibbons PG, Digiovanni C, Hares S, Akelman E: Safe tourniquet use: a review of the evidence . J Am Acad Orthop Surg. 2012, 20:310-9. 10.5435/JAAOS-20-05-310
4. Kumar K, Railton C, Tawfic Q: Tourniquet application during anesthesia: "What we need to know?" . J Anaesthesiol Clin Pharmacol. 2016, 32:424-30. 10.4103/0970-9185.168174
5. Odinsson A, Finsen V: Tourniquet use and its complications in Norway . J Bone Joint Surg Br. 2006, 88:1090-2. 10.1302/0301-620X.88B8.17668
6. Ahmed I, Chawla A, Underwood M, et al.: Tourniquet use for knee replacement surgery . Cochrane Database Syst Rev. 2020, 12:CD012874. 10.1002/14651858.CD012874.pub2
7. Ahmed I, Chawla A, Underwood M, et al.: Time to reconsider the routine use of tourniquets in total knee arthroplasty surgery. Bone Joint J. 2021, 103-B:830-9. 10.1302/0301-620X.103B.BJJ-2020-1926.R1
8. Konrad G, Markmiller M, Lenich A, Mayr E, Rüter A: Tourniquets may increase postoperative swelling and pain after internal fixation of ankle fractures. Clin Orthop Relat Res. 2005, 189-94. 10.1097/01.blo.0000151849.37260.0a
9. Maffulli N, Testa V, Capasso G: Use of a tourniquet in the internal fixation of fractures of the distal part of

the fibula. A prospective, randomized trial. J Bone Joint Surg Am. 1993, 75:700-3. 10.2106/00004623-199305000-00009

10. Farhan-Alanie MM, Dhaif F, Trompeter A, et al.: The risks associated with tourniquet use in lower limb trauma surgery: a systematic review and meta-analysis. Eur J Orthop Surg Traumatol. 2021, 31:967-79. 10.1007/s00590-021-02957-7
11. Davey MS, Davey MG, Hurley ET, Kearns SR: Tourniquet use during open reduction and internal fixation of ankle fractures: a systematic review and meta-analysis. J Foot Ankle Surg. 2022, 61:1103-8. 10.1053/j.jfas.2022.01.019
12. BOAST - The safe use of intraoperative tourniquets . (2021). Accessed: October 19, 2026: https://www.boa.ac.uk/resource/boast-the-safe-use-of-intraoperative-tourniquets.html.
13. Sharma A, Minh Duc NT, Luu Lam Thang T, et al.: A consensus-based checklist for reporting of survey studies (CROSS). J Gen Intern Med. 2021, 36:3179-87. 10.1007/s11606-021-06737-1
14. Eysenbach G: Improving the quality of web surveys: the Checklist for Reporting Results of Internet E-Surveys (CHERRIES). J Med Internet Res. 2004, 6:e34. 10.2196/jmir.6.3.e34
15. Wilson EB: Probable inference, the law of succession, and statistical inference . J Am Stat Assoc. 1927, 22:209-12. 10.2307/2276774
16. Grol R, Grimshaw J: From best evidence to best practice: effective implementation of change in patients' care. Lancet. 2003, 362:1225-30. 10.1016/S0140-6736(03)14546-1
17. Cabana MD, Rand CS, Powe NR, Wu AW, Wilson MH, Abboud PA, Rubin HR: Why don't physicians follow clinical practice guidelines? A framework for improvement. JAMA. 1999, 282:1458-65. 10.1001/jama.282.15.1458
18. Morris ZS, Wooding S, Grant J: The answer is 17 years, what is the question: understanding time lags in translational research. J R Soc Med. 2011, 104:510-20. 10.1258/jrsm.2011.110180
19. Younger AS, McEwen JA, Inkpen K: Wide contoured thigh cuffs and automated limb occlusion measurement allow lower tourniquet pressures. Clin Orthop Relat Res. 2004, 286-93. 10.1097/01.blo.0000142625.82654.b3
20. Olivecrona C, Lapidus LJ, Benson L, Blomfeldt R: Tourniquet time affects postoperative complications after knee arthroplasty. Int Orthop. 2013, 37:827-32. 10.1007/s00264-013-1826-4