Survey of Tourniquet Use in Podiatric Surgery

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Tourniquet use in foot and ankle surgery is common practice; however, the technique varies among foot and ankle surgeons and there are no standard guidelines. To analyze trends in foot and ankle tourniquet use, the authors conducted an e-mail survey. One thousand six hundred sixty-five foot and ankle surgeons were sent a tourniquet-use survey via e-mail, across Canada and the United States. Nineteen percent of the recipients completed and returned the surveys. Eleven (3.4%) rarely or never use a tourniquet and 8 (2.5%) use an Esmarch bandage tourniquet at the ankle. Most use pneumatic ankle cuffs (92% use, 27% use exclusively); many also use thigh cuffs (69%) and some also use calf cuffs (15%). Most thigh-cuff users (62%) experience problems with cuff fit sometimes or often. All but 3 respondents exsanguinate the limb before tourniquet inflation. Specific devices used for exsanguination varied among surgeons. Most commonly used tourniquet pressures range from ≤200 to 350 mm Hg at the ankle and ≤200 to ≥351 mm Hg for the thigh (64% use pressures between 301 and 350 mm Hg). Only 7% of respondents consider limb occlusion pressure when selecting tourniquet cuff pressure. Based on published studies of limb occlusion pressures, these ranges suggest that some of the more common pressure settings may be higher than necessary for many patients. Vascular disease or previous bypass (91%) and deep vein thrombosis (83%) were the most commonly listed contraindications to tourniquet use. Approximately 10% of respondents have either experienced or learned of skin and nerve injuries secondary to lower extremity tourniquet use at any level. The varied responses show a lack of overall consensus on tourniquet pressure settings. Guidelines for optimizing cuff pressure and technique should be established to minimize the risk of complications. (The Journal of Foot & Ankle Surgery 42(2):68–76, 2003)

Key words: tourniquet, pneumatic, survey, standards, complications

Pneumatic tourniquets are commonly used in foot and ankle surgery to maintain a bloodless surgical field and, thereby, allow the surgeon to work with greater technical precision in a safe, clear environment. However, tourniquet use is not without risk. Complications ranging from mild skin irritation to nerve damage and paralysis have been reported (1–5). The use of tourniquets is mostly governed by individual practitioner preferences because practice guidelines to minimize complications and risks are lacking and not clearly defined (6). Thus, there are a wide array of practice guidelines and patterns. In an effort to gauge the current pattern of practice related to tourniquet technique, we conducted a survey of practicing foot and ankle surgeons in the United States and in Canada. The results can be used to estimate the current pattern of practice, to determine which areas of tourniquet practice require further research, and to aid in the development of a risk-minimizing practice guideline for tourniquet use.

Methods

A 17-question survey was e-mailed to 1908 active Fellows of the American College of Foot and Ankle Surgeons. The e-mail address list was provided by the American College of Foot and Ankle Surgeons; all Fellows with e-mail addresses on record as of February 2001 were included. The survey questions are shown in Table 1.

The results are displayed as percentages of the respondents unless otherwise noted. For many of the questions, the respondents may have selected several choices; therefore, the total percentages may add up to greater than 100. When

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TABLE 1 Survey questions

1. How many foot and ankle surgical procedures do you perform in a typical year? (0–50, 50–100, 100–150, over 150)
2. Where do you perform surgery (if more than 1 applies, please rank in order of use)? (teaching hospital, community hospital, office, daycare center, other)
3. What anesthetic do you use (if more than 1 applies, please rank in order of use)? (general, local, regional)
4. Which are the types of foot and ankle procedures you perform (rank in order of frequency)? (forefoot, midfoot, hindfoot, ankle, arthroscopy, trauma/infection)
5. Who applies the cuff to your patients? (surgeon, nurse, anesthetist, other)
6. Is an underlying sleeve or padding material normally used under the cuff? (no, yes: stockinette, yes: cotton cast padding)
7. What location do you use for the cuff (if more than 1 applies, please rank in order of use)? (thigh, calf, ankle)
8. If you apply the cuff at the calf or ankle, how often do you require a sterile cuff? (don't use calf or ankle cuffs, never, less than half of cases, more than half, always)
9. Do you experience problems with the fit of the cuff due to limb taper, or sliding of the cuff distally on the limb during the procedure? (For each location: don't use, never/rarely, sometimes, often)
10. How do you most commonly exsanguinate the foot prior to tourniquet inflation? (don't exsanguinate, esmarch [rubber] bandage, tensor bandage, elevation, other)
11. With local or regional anaesthetic, do you experience problems with patient tolerance of the cuff? (for each location: don't use, never/rarely, sometimes, often)
12. What type of tourniquet machine do you most commonly use? (electronic: Zimmer ATS, other electronic, nonelectronic, don't know)
13. What factors do you consider in determining the cuff pressure? (limb size, limb occlusion pressure, blood pressure, other)
14. What pressure setting do you most commonly use for your patients? (For each location: don't use, 200 or less, 201–250, 251–300, 301–350, over 350)
15. What contraindications do you consider for tourniquet use? (vascular disease or bypass, DVT, infection, tumor, other)
16. What types of tourniquet-related injuries and complications have you experienced or have you heard reported from your colleagues for these 3 locations? (For each location: strike-through bleeding/unable to occlude at normal pressures, nerve-related injuries, skin injuries [blister, rash, edema, contusion, abrasion], fluid under cuff, skin injuries involving fluid leakage under cuff)
17. What types of tourniquet-related hazards, if any, are you concerned about for each location?

results are characterized as "exclusively," the respondents chose 1 answer only. When results are characterized as "included," it stipulates the percentage of those selecting the response either alone or with other choices.

Results

Detailed survey results are shown in Tables 2–4 and Figures 1–4. A total of 1908 surveys were emailed, of which 243 (13%) were undeliverable because of invalid e-mail addresses. Three hundred twenty-five recipients responded, but 8 were unable to complete the survey because of technical problems. The results are thus based on 317 completed surveys (19% response rate of delivered surveys) (Table 2). If it is applicable, the mode (most common response) is indicated.

Of 317 respondents, 306 regularly use a tourniquet. The typical respondent performs more than 100 surgical procedures per year at a community hospital or a surgical daycare center, including elective foot and ankle procedures and emergency treatment of foot and ankle infections/trauma. Some form of local anaesthesia is more commonly used than general anaesthesia (Table 2). Most surgeons apply the tourniquet cuff themselves, and use either cast padding or stockinette under the cuff (Table 3).

Cuff Location, Fit, Pressure Selection, and Tolerance

Ninety-two percent of the respondents use ankle tourniquets (83% use most often and 27% use exclusively) (Table 3), 69% also use thigh tourniquets (9.1% use most often, 2.3% use exclusively), and 15% also use calf tourniquets (1.3% use most often, 0.6% use exclusively). Most (71%) calf and/or ankle tourniquet cuff users never require a sterile tourniquet cuff, and a few (16%) require a sterile tourniquet cuff less than 50% of the time. Even less require a sterile tourniquet cuff more than 50% of the time (3.9%), or always (9%) (Table 3).

Sixty-two percent of thigh-cuff users experience problems with tourniquet cuff fit "sometimes" or "often" (Table 4); 1 surgeon specified that fitting cylindrical cuffs to the typically tapered thighs is difficult. Calf-cuff users were divided between "never/rarely" (49%) and "sometimes" (47%) having problems with cuff fit. Cuff fit is less of a problem at the ankle, because 68% "never/rarely" experience problems (Table 4).

Most surgeons consider blood pressure (82%, 53% exclusively) and limb size (31%) when selecting cuff pressure. Twenty-one percent consider these 2 factors together. Only 7% consider limb occlusion pressure (LOP), but usually in combination with other factors. Only 4 respondents (1.3%) consider LOP exclusively when setting cuff pressure (Fig. 1).

There was a wide range of "most commonly used cuff pressures" reported (Fig. 2). Ankle pressures ranged from $\leq$200 to 350 mm Hg, but the majority (72%) used pressures between 201 and 250 mmHg. In the calf-cuff group, the "most commonly used pressures" ranged from 201 to 350 mm Hg, but the majority (57%) used pressures between 201 and 250 mm Hg. Thigh-cuff users reported "most commonly used pressures" from $<$200 to $>$351 mm Hg, but

TABLE 2 Respondent demographics

Survey response summary	Number	Percent	
Sent	1908	—	
Undeliverable	243	13%	
Delivered	1665	—	
Responded	325	20%	of delivered surveys
Completed	317	19%	of delivered surveys
Don't or rarely use a cuff	11	3%	of completed surveys
Use Esmarch as ankle tourniquet[a]	8	2%	of completed surveys

How many foot and ankle surgical procedures do you perform in a typical year?

No response	0.3%
0–50	8.2%
50–100	29%
100–150	29%
Over 150 (mode)	33%

Where do you perform surgery? (if more than one applies, please rank in order of use)

	Any rank	1st	2nd	3rd	4th
Teaching hospital	34%	18%	10%	1.6%	0.6%
Community hospital	67%	31%	23%	3.5%	0.3%
Office	38%	7.9%	17%	8.5%	0.9%
Daycare center	47%	25%	12%	3.2%	0.6%
Other	1 military, 1 college surgical center				

What anesthesia do you use? (if more than 1 applies, please rank in order of use)

	Any rank	1st	2nd	3rd
General (mode rank 2)	73%	11%	32%	19%
Local (mode rank 1)	93%	63%	14%	5.0%
Regional (mode rank 2)	48%	14%	15%	14%

Which are the types of foot and ankle procedures you perform? (rank in order of frequency)

	Any rank	1st	2nd	3rd	4th	5th	6th
Forefoot (mode rank 1)	99%	86%	6.9%	2.5%	0.0%	1.3%	0.3%
Midfoot (mode rank 2)	95%	0.9%	54%	24%	7.9%	4.4%	1.6%
Hindfoot (mode rank 3)	93%	2.2%	25%	47%	15%	1.3%	0.0%
Ankle (mode rank 4)	56%	0.9%	1.6%	6.3%	25%	17%	4.4%
Arthroscopy (mode rank 6)	38%	0.3%	0.6%	2.8%	4.4%	11%	18%
Trauma/infection (mode rank 4)	75%	3.2%	11%	14%	22%	17%	5.7%

[a]Three of 317 (0.95%) use Esmarch ankle tourniquet exclusively.

most (62%) used pressures between 301 and 350 mm Hg (Fig. 2).

Ankle cuff users "never/rarely" (48%) or "sometimes" (48%) encountered patient intolerance of the cuff under local and regional anesthesia. Calf-cuff users reported slightly higher rates of cuff intolerance (never/rarely, 32%; sometimes, 66%). Many respondents commented that using sedation with the local anesthetic prevents most of the intolerance problems associated with ankle cuffs and that thigh cuffs are not well tolerated unless general or spinal anesthesia is used. Twenty-six percent of the respondents specifically indicated that, when using a thigh cuff, they use forms of anesthesia other than local anesthesia (Table 4).

Esmarch Bandage Ankle Tourniquets

A small number of respondents reported using an Esmarch (Davol, inc, Providence, RI) bandage as an ankle tourniquet (8 of 317 [2.5%] use, 3 of 317 [1%] use exclusively). One respondent specified the risk of nerve injury caused by the unregulated Esmarch pressures as a concern.

Exsanguination

Exsanguination of the limb portion is typically accomplished by elevation and/or by compression from distal to proximal up to the tourniquet site just before tourniquet

TABLE 3 Current practice

Who applies the cuff to your patients?		
No response	2%	
	Exclusively	Included
Surgeon (mode)	54%	77%
Nurse	14%	30%
Anesthetist	0.6%	1.6%
Other	5.7%	15%

Is an underlying sleeve or padding material normally used under the cuff?	
No response	0.9%
No	1.3%
Stockinette	2.8%
Cotton cast padding (mode)	88%
Stockinette and/or cast pad	6.6%

What location do you use for the cuff? (if more than 1 applies, please rank in order of use)				
No response	2.2%			
	Any rank	1st	2nd	3rd
Thigh (mode rank 2)[a]	69%	9.1%	53%	3.2%
Calf (mode rank 3)[b]	15%	1.3%	5.0%	8.2%
Ankle (mode rank 1)[c]	92%	83%	5.7%	0.6%

If you apply the cuff at the calf or ankle, how often do you require a sterile cuff?[d]	
No response	1.9%
Don't use calf/ankle	2.2%
Never (mode)	71%
Less than ½ cases	16%
More than ½	3.9%
Always	8.9%

How do you most commonly exsanguinate the foot prior to tourniquet inflation?[e]		
No response	1.9%	
Don't exsanguinate	0.9%	
	Exclusively	Included
Esmarch bandage (mode)	55%	74%
Tensor bandage	4.2%	7.5%
Elevation	17%	40%
Other	0.0%	1.3%

What type of tourniquet machine do you most commonly use?[f]		
No response	6.9%	
Don't know	23%	
	Exclusively	Included
Electronic Zimmer ATS (mode)	49%	60%
Other electronic	26%	32%
Nonelectronic	11%	21%

[a]Use thigh exclusively: 7 of 310 respondents (2.3%).
[b]Use calf exclusively: 2 of 310 respondents (0.6%).
[c]Use ankle exclusively: 84 of 310 respondents (27%).
[d]Net of no response or don't use calf/ankle.
[e]Twenty-two percent use Esmarch or Tensor with elevation; 4 respondents use elevation with manual compression. Percentages are net of no response and don't exsanguinate.
[f]Eighty percent use electronic only (Zimmer ATS, non-Zimmer, or both); 9.4% use both electronic (any brand) and nonelectronic. Percentages are net of no response and don't know.

TABLE 4 Perioperative difficulties

Do you experience problems with the fit of the cuff due to limb taper or sliding of the cuff distally on the limb during the procedure?[a]			
	Thigh	Calf	Ankle
Never/rarely	39%	49%	68%
Sometimes	52%	47%	22%
Often	9.5%	4.3%	10%

With local or regional anaesthetic, do you experience problems with patient tolerance of the cuff?[a]			
	Thigh	Calf	Ankle
No response	6.6%	10%	5.4%
Don't use	45%	73%	4.7%
Never/rarely	48%	32%	48%
Sometimes	38%	66%	48%
Often	14%	1.8%	3.2%

[a]Net of no response and don't use for each location.

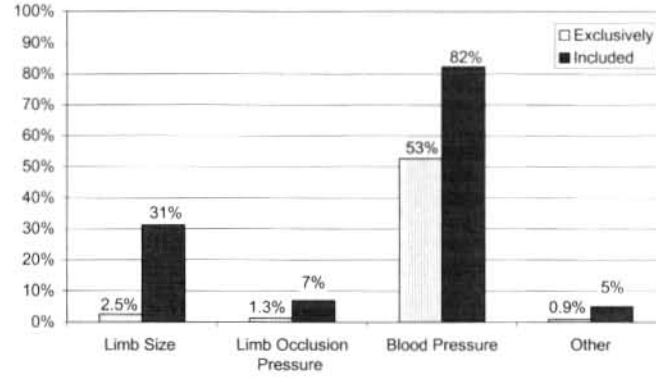

FIGURE 1 Responses to survey question 13: "What factors do you consider in determining cuff pressure?"

inflation. Most surgeons use an Esmarch bandage to exsanguinate (74% use and 55% exclusively) and 7.5% use a tensor bandage. Seventeen percent elevate only and 22% use an Esmarch or tensor bandage with elevation. Only 3 respondents reported that they do not exsanguinate. Some respondents specified that they use elevation only (or do not exsanguinate at all) in cases involving infection or tumor.

Tourniquet Instrument

Seven percent gave no response and 23% did not know what type of tourniquet instrument they most commonly used. These seemingly high proportions are likely caused by surgeons working at different sites with different equipment. Of the remaining surgeons, 80% most commonly use electronic tourniquet instruments only, 11% use a nonelectronic instrument, and 9% use both electronic and nonelectronic instruments.

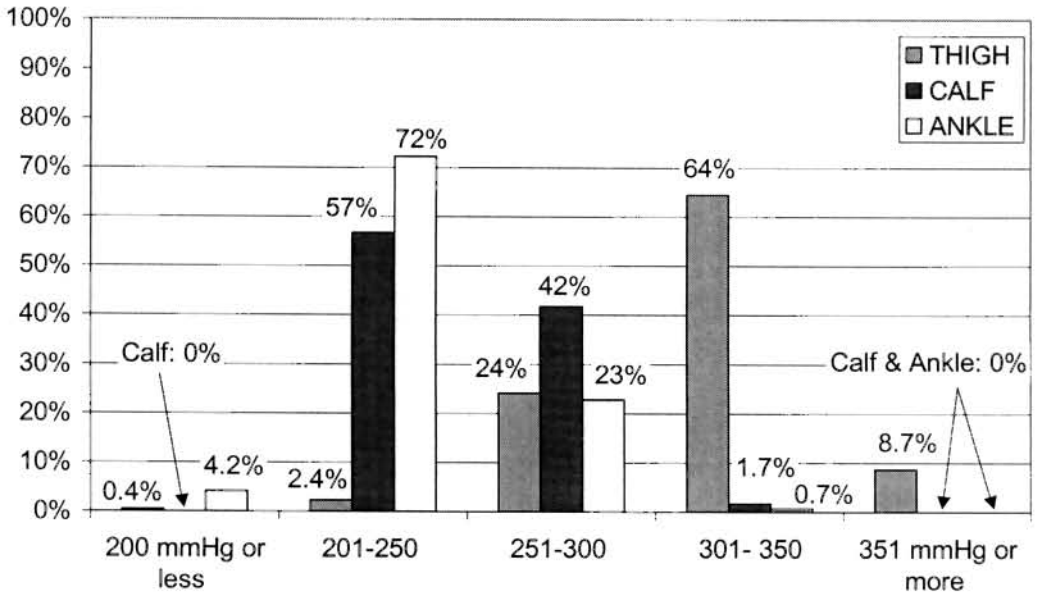

FIGURE 2 Responses to survey question 14: "What pressure setting do you most commonly use for your patients?"

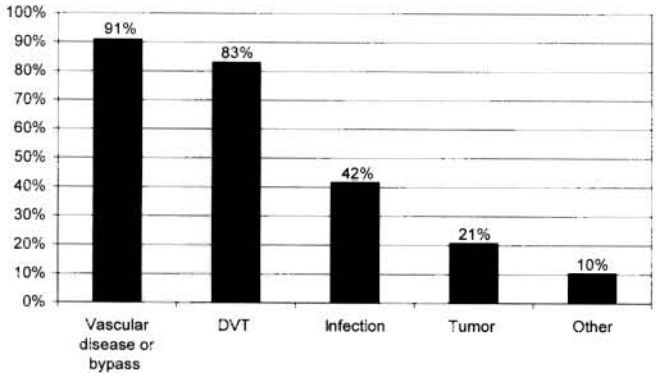

FIGURE 3 Responses to survey question 15: "What contraindications do you consider for tourniquet use?"

Contraindications

Vascular disease or bypass was the most commonly listed contraindication (91%), followed by deep vein thrombosis (DVT) (83%), infection (42%), and tumor (21%). Additional contraindications noted were sickle cell trait (9 respondents), diabetes (4), and hematologic or bleeding disorders and coagulopathy (4).

Complications

Ankle-cuff users have experienced or have heard colleagues report the following complications: strike-through bleeding or inability to occlude at normal cuff pressures (39%), nerve injuries (28%), skin injuries without fluid collecting under the cuff (23%), and skin injuries involving fluids (3.3%). Thirty-three percent gave no response.

Similarly, for calf-cuff users, 12%, 14%, and 10% reported strike-through bleeding, nerve related injuries, and skin injuries without fluid under the cuff, respectively, and only 1 respondent mentioned skin injuries involving fluids. For thigh-cuff users, the corresponding rates were 30%, 21%, and 15%, with only 2 respondents mentioning skin injuries involving fluids.

Tourniquet-Related Hazards of Concern and General Comments

Seventy-three of 317 respondents (23%) provided comments and thoughts on tourniquet-related hazards. Nerve injury and DVT were the most common concerns. Eighteen respondents noted nerve injury and DVT as concerns. Eight surgeons mentioned concerns with tourniquet time, 2 specifying a limit of 2 hours and 3 specifying a limit of 90 minutes. Postoperative pain or swelling was a concern mentioned by 4 respondents, 1 of whom specifically associated postoperative discomfort with tourniquet time greater than 90 minutes. In addition, 3 of 11 respondents who never or rarely use a tourniquet specified postoperative pain as a reason. Specific complication rates were 3 neurapraxias in 8 years, 4 complications in 2000 cases, none in more than 1000 cases, and 1 DVT in 18 years. Bruising, crushing injury, or muscle damage (including 1 calf-muscle rupture) was mentioned by 6 respondents. Twenty-eight of these 73 respondents mentioned that they did not have concerns or that complications were rare or had never been encountered, with a range of 8 to 31 years of clinical practice.

Discussion

A survey of this nature can only report the responding surgeon's estimates, opinions, and experience; therefore, it

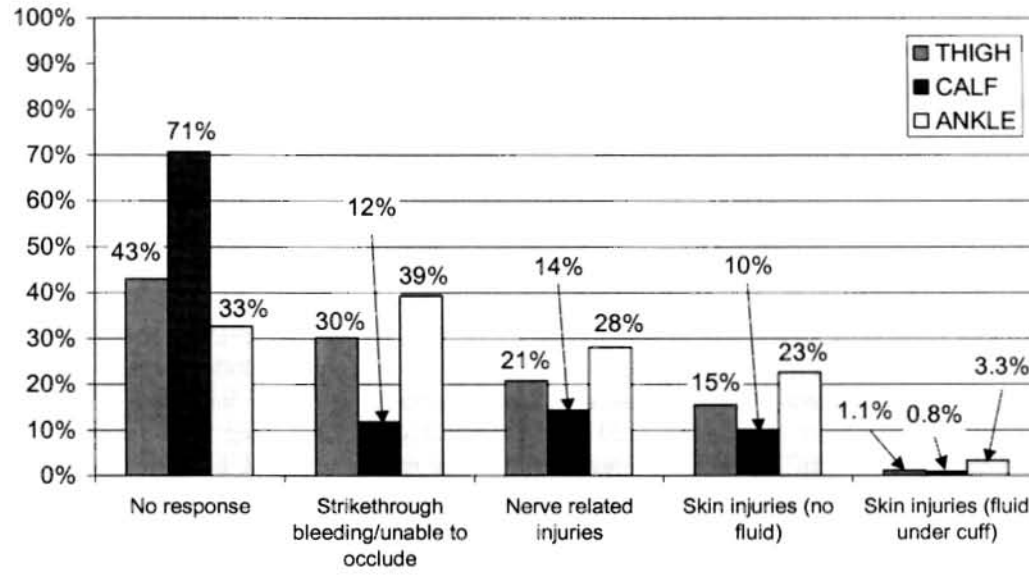

FIGURE 4 Responses to survey question 16: "What types of tourniquet-related injuries and complications have you experienced or have you heard reported from your colleagues for these 3 locations (thigh, calf, ankle)?"

cannot be used to establish recommended practice guidelines. The results can, however, indicate which aspects of reported practice agree with the existing evidenced-based literature. The results also indicate lack of consensus among respondents in certain aspects of practice, suggesting that existing clinical evidence should be reexamined and possibly researched further. There are also limitations on the specificity of the questions and responses in a general survey of this type, particularly regarding contraindications and complications. The intention of the survey is to indicate the general trends and the areas of concern among respondents. Evidence-based literature in each specific area would need to be consulted to estimate actual complication rates and to verify the statistical significance of these results.

The 19% response rate is lower than expected. In a parallel survey we sent by conventional mail to 250 orthopaedic surgeons with foot and ankle specializations, the response rate was 55% (7), and in a smaller tourniquet practice survey e-mailed to pediatric surgeons, the response rate was 33 of 52 (63.5%) (8). An e-mail survey allows easy access to a large sample of the population as well as an ease of ability to respond; however, some replies indicated that there were technical difficulties in some cases, and it has to be assumed that a substantial number of replies were prevented by these technical problems. Nevertheless, the response of more than 300 podiatric surgeons located throughout the United States and Canada provides a substantial sample size that is sufficient to profile the current tourniquet practice of respondents.

It cannot be determined if there are biases in tourniquet technique between respondents and nonrespondents; however, it is likely that those surgeons who regularly use tourniquet control in surgery were more likely to complete the survey than surgeons who do not use a tourniquet. Therefore, the true percentage of surgeons who do not use tourniquet control is likely higher than the 11 of 317 (3.4%) indicated in our results. Similarly, it is also reasonable to assume that a number of recipients who use an Esmarch bandage as a tourniquet but never use pneumatic tourniquets may have felt that the survey was not intended for them because of the number of questions specific to pneumatic cuff technique. Therefore, the number of podiatric surgeons using Esmarch tourniquets is likely higher than the 8 of 317 (2.5%) indicated in our results.

For both thigh and ankle tourniquets, fit problems related to limb taper have been addressed by contoured cuff designs (9–12). It is well established in the literature that the minimum pressure required to safely maintain a bloodless field (limb occlusion pressure (LOP) plus a safety margin to prevent bleed-through and venous congestion) should be used and that lower pressure reduces the risk of complications (9–18). LOP is defined as the minimum cuff pressure required to occlude arterial flow in the involved limb (using the tourniquet cuff as applied for the surgical case and measured before cuff inflation), and therefore accounts for all factors affecting occlusion, including blood pressure, limb size, tissue properties, cuff fit, and cuff design (9,10,12–16). LOP is measured by gradually increasing cuff pressure and by noting the pressure at which distal arterial flow stops. Distal arterial flow can be monitored by Doppler stethoscope, which is somewhat awkward and time consuming. We are currently developing an automated plethysmographic technique (by using a modified tourniquet instrument) that may make LOP measurement at the beginning of each case faster, more precise, and more practical (9, 12). Only 1 respondent specified using systolic blood pressure (SBP) + 100 mm Hg, a technique that, although not leading to the optimum pressure given by LOP, will likely lead to

lower pressures for many patients compared with the most commonly used pressures reported.

The most commonly used ankle-cuff pressures of 201 to 250 mm Hg roughly agree with optimum ankle-cuff pressures based on LOP plus a 40 to 60 mm Hg safety margin as reported in clinical and volunteer studies (9, 13). However, 22% most commonly use 251 to 300 mm Hg, and 2 ankle cuff users (0.7%) use 301 to 350 mm Hg, pressures which have been reported as being safe (19), but are almost certainly higher than necessary for most patients (9, 13, 14). A more commonly stated safe maximum ankle-cuff pressure is 250 mm Hg (13, 20–22).

A substantial number of calf-cuff users (42%) most commonly used pressures ranging from 201 to 350 mm Hg. Pressures greater than 250 mm Hg should seldom be required at the calf (23), particularly if a wide, contoured cuff is used and if LOP measurement is used to set cuff pressure (9, 11).

Among thigh-cuff users, only 2.8% report they most commonly use pressures of 250 mm Hg or less at the thigh, a range that would correspond with typical optimal cuff settings based on LOP, a method that has been shown to provide adequate occlusion and reduce average pressures (12), or typical systolic blood pressure + 100 mm Hg (24). Seventy-three percent reported using 301 mm Hg or more, pressures which are almost certainly higher than necessary for most patients (12, 24).

Using the minimum effective tourniquet pressure should improve tourniquet tolerance. In a volunteer study, Estebe et al (25) found that using a cuff pressure setting of LOP + 10 mm Hg reduced average cuff pressure by 42% for a wide cuff and 22% for a narrow cuff compared with SBP + 100 mm Hg. The wide cuff occluded blood flow in the arm, with approximately 25% lower pressures on average than the narrow cuff, and at these lower pressures, the wide cuff was less painful (25). In our ongoing clinical studies in which LOP technique and wide cuffs are being used to optimize lower leg cuff pressures, we have observed a trend toward better cuff tolerance in cases using local anesthesia and sedation. Similarly, in general anesthesia cases, we have observed a trend toward less required depth of anesthesia and corresponding lower consumption of anaesthetic drugs (supported by consistent comments about less general anesthesia requirement from the anesthesiologists. Even in general anesthesia cases, local anesthesia is administered at the start of the case; therefore, the lower general anesthesia use can be assumed to be related to the lower cuff pressures).

It has been stated in the literature that Esmarch ankle tourniquets do not cause a higher incidence of complications (22, 26). However, laboratory studies have shown that pressures generated beneath the device can be dangerously high when using a typical technique (27–29). In multiuser testing of various Esmarch widths and number of wraps, Biehl et al (22) found that the average pressures generated were reasonable; however, the standard deviations (35 to 53 mm Hg) and maxima (321 to 413 mm Hg) indicate that unnecessarily high pressures would commonly be applied in the typical practice setting (22).

The Esmarch bandage has been criticized as being too aggressive for exsanguinations, with an elastic bandage preferred because of its lighter compression (19). Several case reports of pulmonary embolism on exsanguination when using an Esmarch bandage have been published, and it has been suggested that the sudden increase of venous flow dislodged preexisting thrombi (30–33).

Nerve injury comments were not specific to ankle cuffs, suggesting that concern with injury to the unprotected nerves at the ankle (34,35) is no longer widely held. Indeed, surgeons have argued that this concern is unfounded based on retrospective reviews (19,36). The current survey was not specific with regard to where the local anaesthetic was administered, and neurapraxias caused by a posterior tibial nerve block would not be distinguishable from ankle tourniquet–induced neurapraxia. One prospective randomized trial suggests that thigh-cuff use does not increase the risk of DVT for forefoot surgery patients (37). In the literature, the maximum safe periods of continuous tourniquet ischemia are most commonly considered to be 1 hour (20), 90 minutes (21), or 2 hours (6). The 90-minute limit is supported by an animal study in which a significant increase in myofibrillar degeneration index was observed when the initial period of continuous tourniquet ischemia was increased from 90 minutes to 2 hours. It was concluded that three 60-minute or two 90-minute periods separated by 5-minute reperfusion intervals produced minor injury to the muscle cells compared with a 2 + 1 hour pattern or a 3-hour uninterrupted period (38). Concern about postoperative pain may be reduced through use of optimized cuff pressures as discussed previously, and 1 clinical series of thigh-cuff applications shows that lower cuff pressures reduced postoperative pain (24).

In a 1990 European survey involving more than 75,000 surgical procedures, skin injuries (usually reddening with blisters) were reported in 1.4% of lower limb cases (2). In the survey, 15% of the responding clinics did not use any padding material under the cuff. Many injuries were attributed to fluids (such as antimicrobials used for skin preparation) collecting under the cuff and causing chemical burns or skin irritation, whereas other skin injuries occurred without fluid under the cuff. The current survey results show a different pattern: 14 respondents (4.4%) reported that they have experienced or heard of skin injuries involving fluids, 122 (38%) reported skin injuries without fluid, and only 4 (1.3%) reported going without padding under the cuff. Most respondents use cotton cast padding (88%). One case of severe skin injury has been reported from a poorly fitting thigh tourniquet sliding off of the cotton cast padding (3).

Recent studies show that a snug-fitting 2-layer stockinette or tubular elastic sleeves reduce pinching of the skin under the cuff more effectively than loose cotton padding (8, 39).

Summary

Based on completed survey responses from 317 of 1665 doctors of podiatric medicine who are Fellows of the American College of Foot and Ankle Surgeons in the United States and Canada, ankle tourniquets are most commonly used, followed by thigh and calf cuffs. Few respondents never or rarely use a tourniquet (11 of 317) and few use an Esmarch bandage as a tourniquet (8 of 317); however, these rates may be underestimated because of sampling bias. Almost all tourniquet users use some form of limb protection material under the cuff and most usually use an electronic tourniquet instrument. The wide range of commonly used pressures reported shows a lack of overall consensus on tourniquet pressure settings. Based on studies of limb occlusion pressures (9, 10, 12–16), many of the most commonly used pressures may be higher than necessary for many patients. Very few respondents use optimal cuff-pressure selection techniques such as limb occlusion pressure. The lower cuff pressures enabled by these techniques may serve to lower the potential for tourniquet-related complications and improve cuff tolerance, thereby reducing the depth of required anesthesia and reducing postoperative pain. Nerve-related injuries have been experienced or heard reported from colleagues by 28% of ankle-cuff users and by 21% of thigh-cuff users. Nerve injury and DVT are the most common concerns mentioned. Guidelines for optimizing cuff pressure and technique should be established to minimize the risk of complications.

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