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Practice of tourniquet use in Turkey: a pilot study

Hakan BOYA[1], Bahattin TUNCALI[2], Özal ÖZCAN[3], Şükrü ARAÇ[1], Cengiz TUNCAY[4]

[1]Başkent University Faculty of Medicine, Zübeyde Hanim Practice and Research Center, Department of Orthopaedics and Traumatology, İzmir, Turkey
[2]Başkent University Faculty of Medicine, Zübeyde Hanim Practice and Research Center, Department of Anesthesiology, İzmir, Turkey
[3]Afyonkocatepe University Faculty of Medicine, Department of Orthopaedics and Traumatology, Afyonkocatepe, Turkey
[4]Başkent University Faculty of Medicine, Department of Orthopaedics and Traumatology, Ankara, Turkey

Objective: The aim of the present pilot study was to evaluate patterns in the current practice of tourniquet use in Turkey. The results of this study can provide detailed information regarding tourniquet use and evaluate the need for guidelines on tourniquet use in Turkey.

Methods: The questionnaire was sent to orthopedic residents and surgeons by either giving printed questionnaires directly or by establishing preliminary communication with surgeons and then sending questionnaires by e-mail. Participating staff consisted of 3 groups: Group 1: orthopedic surgeons; Group 2: orthopedic residents; and Group 3: orthopedic academic staff. Statistical differences in tourniquet use were analyzed among the groups.

Results: Use of mechanical tourniquet was significantly higher in Group 1. Plain cuffs were used in orthopedic surgical practice more frequently. Assistant and orthopedic theatre personnel were commonly reported by participants as the tourniquet applicant. Periodic educational practice was not routine. The number of reported complications was higher in Group 3. Cuff padding was generally routine practice. Scientifically valid options at lowest inflation pressure were not observed among the results at the expected rates.

Conclusion: The results of this pilot study indicate that there is wide variation in some aspects of tourniquet practice in Turkey. The differences are not acceptable because of the potential for significant complications with some practices. There is a need to provide and ensure adequate education to provide the best patient care. Furthermore, protocols should be developed for acceptable standards of tourniquet use.

Keywords: Extremity; orthopedic; tourniquet.

Tourniquets are widely used in orthopedic operating theatres. The principle cause for using a tourniquet is to provide better operative conditions by creating a bloodless surgical field.[1,2] In spite of its advantages, tourniquet use is not absolutely safe, with possible systemic and local harmful effects.[2]

Physicians are responsible for safe tourniquet use,[2] as well as any consequences that arise from their use.[3,4] With adequate education, the adverse effects are easily preventable. However, there is only 1 formal examination to test knowledge and describe general guidelines on tourniquet use for orthopedic surgeons in Turkey.[5]

Correspondence: Hakan Boya, MD. Başkent Üniversitesi, Ortopedi ve Travmatoloji Anabilim Dalı Zübeyde Hanım Uygulama ve Araştırma Merkezi, Bostanlı, Karşıyaka, İzmir, Turkey.
Tel: +90 000 – 506 – 343 36 68 e-mail: hakanboya@yahoo.com

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The aim of the present pilot study was to evaluate patterns in the current practice of tourniquet use in Turkey. The results of this study can provide detailed information about tourniquet use among orthopedic surgeons, orthopedic residents, and orthopedic academic staff, and define the extent of the need for guidelines on tourniquet use in Turkey.

Materials and methods

This study was approved by Baskent University Institutional Review Board (Project no:KA 13/64) and supported by Baskent University Research Fund. The data for this cross-sectional descriptive study was collected from 98 medical personnel.

A draft of the questionnaire containing 18 questions was approved by all authors. The first 12 questions address the surgeon, hospital, and technique of pneumatic tourniquet application. The remaining 6 questions address the surgeon's knowledge of pneumatic tourniquet use. The first section (initial 12 questions) recorded the title of the surgeon, the institution where the surgeon works, type of pneumatic tourniquet, type of cuff, identity of person who is applying the tourniquet, regular education about tourniquet use in that clinical unit, experience of complications in that clinical unit, recording of application details (tourniquet type and time, cuff type, pressure level), padding beneath the tourniquet, cuff localization on extremity, determining cuff pressure, and method of exsanguination. The second section (remaining 6 question) questioned timing of antibiotic administration, secure tourniquet time for adult and pediatric patients, cause of intraoperative bleeding, tourniquet strategy in longer operations, and contraindications of tourniquet use (Table 1).

The questionnaire was sent to orthopedic residents and orthopedic surgeons working in training and research hospitals, university hospitals, state hospitals, and private hospitals by either giving printed questionnaires directly or, after preliminary communication with surgeons was established, sending questionnaires by e-mail. The hospitals were chosen randomly. All orthopedic sur-

Table 1. Survey questions.

1. What is your academic title? (orthopedic surgeon, orthopedic resident, orthopedic academic staff [professor, associated professor, assistant professor])
2. Where do you perform surgery? (state hospital, university hospital, training and research hospital, private hospital, other)
3. What type of tourniquet do you use? (electronic, mechanical)
4. What type of tourniquet cuff do you use? (plain, conical, plain or conical according to extremity width)
5. Who applies tourniquet cuff to your patients? (orthopedic surgeon, orthopedic resident, nurse, orthopedic theatre personnel, other)
6 Is there periodic educational practice about tourniquet use in your hospital? (no; yes, biennially; yes, once a year; yes, biannually; other)
7. Have you experienced any tourniquet-related complications? (no; yes, in a patient; yes, in more than one patient; other)
8. Do you record tourniquet type, cuff type, inflation pressure, and tourniquet time during orthopedic theatre routinely? (yes, no)
9. Do you prefer using underlying skin protection material below the cuff? (yes, no)
10. Where do you apply tourniquet cuff on the extremity of a patient? (most proximally, most distally, region of most muscle mass, disregard the region)
11. For lower and upper extremities, what pressure setting do you most commonly use for your patients? (___ mmHg for upper extremity ___ mmHg for lower extremity, systolic blood pressure plus 100 mmHg, limb occlusion pressure or arterial occlusion pressure determination method, arterial occlusion pressure estimation method, other)
12. How do you exsanguinate the limb prior to tourniquet inflation? (do not exsanguinate, elevation only, Esmarch bandage, both elevation and Esmarch bandage, other)
13. How many minutes before tourniquet inflation do you give antibiotics? (15 min, 20 min, 30 min, 45 min, other)
14. What do you prefer as maximum safe tourniquet inflation time for adult patients? (60 min for upper extremity, 90 min for lower extremity; 90 min for upper extremity, 120 min for lower extremity; 60 min for upper extremity, 120 min for lower extremity; 120 min for upper extremity, 120 min for lower extremity; other)
15. What do you prefer as maximum safe tourniquet inflation time for pediatric patients? (120 min, 90 min, 75 min, 60 min, other)
16. If there is bleeding despite using tourniquet during operation, what is the most likely cause? (unsatisfactory initial cuff inflation pressure, increased blood pressure during surgery, tourniquet cuff pressure decreased intraoperatively, all, none)
17. What is your practice if there is a need to exceed safe tourniquet inflation time during surgery? (proceed with the surgery without tourniquet; deflate tourniquet, reuse after 5 min break; deflate tourniquet, reuse after 15 min break; deflate tourniquet, reuse after 30 min break; other)
18. Which is/are contraindication(s) of tourniquet application during extremity surgery? (peripheral vascular disease, infection, malignancy, sickle cell anemia history, all of the above)

Table 2. Survey results, personal information of the physicians.

	n	%
Q1. What is your academic title?		
Orthopedic surgeon	42	42.9
Orthopedic resident	36	36.7
Orthopedic academic staff	20	20.4
Professor	13	13.3
Associated professor	5	5.1
Assistant professor	2	2
Q2. Where do you perform surgery?		
State hospital	23	23.5
University hospital	48	49
Training and research hospital	5	5.1
Private hospital	22	22.4

geons and residents, as well as the majority of academic staff, were selected from the Aegean Region in Turkey. Additionally, questionnaires were sent to randomly chosen orthopedic academic staff outside the Aegean Region by e-mail.

Participating medical staff consisted of 3 groups: Group 1: orthopedic surgeons; Group 2: orthopedic residents; and Group 3: orthopedic academic staff (professor, associated professor, and assistant professor). Statistical differences in tourniquet use were analyzed among the groups. Completed questionnaires were recorded, and results were exported to SPSS software (version 16.0, SPSS Inc., Chicago, IL, USA) for analysis. Descriptive statistics, one-way analysis of variance and chi-squared test analysis were used. P values <0.05 were considered significant.

Results

The study included 98 participants who are actively working in orthopedic units. The majority of participants worked in a university hospital (n=48, 49%). Detailed survey results are shown in Tables 2 and 3.

The number of participants who used mechanical tourniquet was significantly higher in Group 1 (F=13.861, p=0.000; Pearson's chi-squared test=22.138, SD=2, p=0.000). Plain cuffs were used in orthopedic surgical practice more frequently (n=72,

Table 3. Survey results, current practice (G1: Group 1; G2: Group 2; G3: Group 3).

	n	%
Q3. What type of tourniquet do you use?		
Electronic	81 (G1: 26; G2: 35; G3: 20)	82.7
Mechanical	17 (G1: 16; G2: 1; G3: 0)	17.3
Q4. What type of tourniquet cuff do you use?		
Plain	72 (G1: 32; G2: 28; G3: 12)	73.5
Conical	5 (G1: 4; G2: 1; G3: 0)	5.1
Plain or conical according to extremity width	21 (G1: 6; G2: 7; G3: 8)	21.4
Q5. Who applies tourniquet cuff to your patients?		
Orthopedic surgeon	20 (G1: 16; G2: 2; G3: 2)	20.6
Orthopedic resident	43 (G1: 7; G2: 30; G3: 6)	44.3
Nurse	0	0
Orthopedic theatre personnel	33 (G1: 19; G2: 3; G3: 11)	34.0
Other (herself/himself)	1 (G3)	1.0
(One participant did not answer the question)		
Q6: Is there periodic educational practice about tourniquet use in your hospital?		
No	67 (G1: 29; G2: 26; G3: 12)	69.1
Yes, biennially	5 (G1: 1; G2: 3; G3: 1)	5.2
Yes, once a year	16 (G1: 7; G2: 7; G3: 2)	16.5
Yes, biannually	5 (G1: 2; G2: 0; G3: 3)	5.2
Other	4 (G1: 2; G2: 0; G3: 2)	4.1
(One participant did not answer the question)		
Q7. Have you experienced any tourniquet-related complications?		
No	72 (G1: 37; G2: 27; G3: 8)	74.2
Yes, in one patient	8 (G1: 2; G2: 4; G3: 2)	8.2
Yes, in more than one patient	16 (G1: 2; G2: 5; G3: 9)	16.5
Other	1 (G3)	1.0
(One participant did not answer the question)		

Table 3. Survey results, current practice (G1: Group 1; G2: Group 2; G3: Group 3). (cont.)

	n	%
Q8. Do you record tourniquet type, cuff type, inflation pressure, and tourniquet time routinely in the orthopedic theatre?		
Yes	77 (G1: 30; G2: 30; G3: 17)	78.6
No	21 (G1: 12; G2: 6; G3: 3)	21.4
Q9. Do you prefer using an underlying skin protection material below the cuff?		
Yes	93 (G1: 41; G2: 34; G3: 18)	94.9
No	5 (G1: 1; G2: 2; G3: 2)	5.1
Q10. Where do you apply tourniquet cuff on the extremity of a patient?		
Most proximally	79 (G1: 34; G2: 33; G3: 12)	80.6
Most distally	1 (G1)	1.0
Region of most muscle mass	16 (G1: 7; G2: 3; G3: 6)	16.3
Disregard the region	2 (G3)	2.0
Q11. In lower and upper extremities, what pressure settings do you most commonly use for your patients?		
___ mmHg for upper extremity, ___ mmHg for lower extremity (fixed inflation pressures)	38 (G1: 18; G2: 13; G3: 7)	38.8
Systolic blood pressure plus 100 mmHg	51 (G1: 20; G2: 20; G3: 11)	52.0
Limb occlusion pressure or arterial occlusion pressure determination method	1 (G1)	1.0
Arterial occlusion pressure estimation method	2 (G1: 1; G2: 1)	2.0
Other	6 (G1: 2; G2: 2; G3: 2)	6.1
Q12. How do you exsanguinate the limb prior to tourniquet inflation?		
Do not exsanguinate	9 (G1: 2; G2: 6; G3: 2)	9.2
Elevation only	23 (G1: 11; G2: 8; G3: 4)	23.5
Esmarch bandage	45 (G1: 23; G2: 13; G3: 9)	45.9
Both elevation and Esmarch bandage	21 (G1: 7; G2: 9; G3: 5)	21.4
Other	0	0
Q13. How many minutes before tourniquet inflation do you give antibiotics?		
15 min	19 (G1: 8; G2: 4; G3: 7)	19.4
20 min	13 (G1: 5; G2: 7; G3: 1)	13.3
30 min	55 (G1: 22; G2: 22; G3: 11)	56.1
45 min	5 (G1: 3; G2: 2; G3: 0)	5.1
Other	6 (G1: 4; G2: 1; G3: 1)	6.1
Q14. What do you prefer as maximum safe tourniquet inflation time for adult patients?		
60 min for upper extremity, 90 min for lower extremity	22 (G1: 12; G2: 5; G3: 5)	22.4
90 min for upper extremity, 120 min for lower extremity	44 (G1: 12; G2: 23; G3: 9)	44.9
60 min for upper extremity, 120 min for lower extremity	8 (G1: 7; G2: 1; G3: 0)	8.2
120 min for upper extremity, 120 min for lower extremity	21 (G1: 10; G2: 7; G3: 4)	21.4
Other	3 (G1: 1; G2: 0; G3: 2)	3.1
Q15. What do you prefer as maximum safe tourniquet inflation time for pediatric patients?		
120 min	14 (G1: 5; G2: 7; G3: 2)	14.4
90 min	42 (G1: 13; G2: 17; G3: 12)	43.3
75 min	7 (G1: 2; G2: 3; G3: 2)	7.2
60 min	31 (G1: 20; G2: 9; G3: 2)	32.0
Other	3 (G1: 2; G2: 0; G3: 1)	3.1
(One participant did not answer the question)		
Q16. If there is bleeding despite using a tourniquet during operation, what is the most likely cause?		
Unsatisfactory initial cuff inflation pressure	15 (G1: 4; G2: 10; G3: 1)	15.3
Increased blood pressure during surgery	6 (G1: 2; G2: 4; G3: 0)	6.1
Decreased intraoperative tourniquet cuff pressure	24 (G1: 11; G2: 7; G3: 6)	24.5
All	51 (G1: 25; G2: 15; G3: 11)	52.0
None	2 (G3)	2.0

Table 3. Survey results, current practice (G1: Group 1; G2: Group 2; G3: Group 3). (cont.)

	n	%
Q17. What is your practice if there is need to exceed safe tourniquet inflation time during surgery?		
Proceed with the surgery without tourniquet	48 (G1: 22; G2: 19; G3: 7)	49.0
Deflate the tourniquet, reuse after 5 min break	12 (G1: 2; G2: 8; G3: 2)	12.2
Deflate the tourniquet, reuse after 15 min break	24 (G1: 14; G2: 2; G3: 8)	24.5
Deflate the tourniquet, reuse after 30 min break	11 (G1: 3; G2: 7; G3: 1)	11.2
Other	3 (G1: 1; G2: 0; G3: 2)	3.1
Q18. Which is/are contraindication(s) of tourniquet application for extremity surgeries?		
Peripheral vascular disease	13 (G1: 6; G2: 7; G3: 0)	13.4
Infection	3 (G1: 0; G2: 1; G3: 2)	3.1
Malignancy	3 (G1: 2; G2: 1; G3: 0)	3.1
Sickle cell anemia history	2 (G1: 1; G2: 1; G3: 0)	2.1
All of the above	76 (G1: 33; G2: 26; G3: 17)	78.4
(One participant did not answer the question)		

73.5%) than conical cuffs (n=5, 5.1%). Assistant (n=43, 44.3%) and orthopedic theatre personnel (n=33, 34%) were commonly reported as the tourniquet applicant. Periodic education was not routine practice in most of the clinics, as 67 participants (69.1%) responded "no."

Most participants (n=72, 74.2%) had encountered no complications. The number of reported complications was statistically significantly higher in Group 3 (F=13.336, p=0.000; Pearson's chi-squared test=19.004, SD=1, p=0.000). Technical details about tourniquet use appear to be recorded regularly in the operating theatre (n=77, 78.6%). Underlying skin protection material underneath the cuff was reported by 93 participants (94.9%). According to determination of cuff localization, half of the participants in Group 3 reported that they applied the cuff on the region of the extremity with the greatest muscle mass (F=5.530, p=0.005). Fixed inflation pressures (n=38, 38.8%) and systolic blood pressure plus 100 mmHg (n=51, 52%) were commonly reported options for setting the cuff pressure. Esmarch bandage exsanguination procedure was the most commonly reported procedure by participants (n=45, 45.9%).

A 20–30 minute interval between antibiotic administration and tourniquet inflation was the most frequently chosen interval by survey participants (n=68, 69.4%). Ninety minutes for upper extremity and 120 minutes for lower extremity were reported as maximum safe tourniquet inflation time for adult patients by 44 participants (44.9%). Only 38 participants (39.2%) reported equal or below 75 minutes in pediatric patients for maximum safe tourniquet inflation time. There was a statistically significant difference among the groups with respect to maximum safe tourniquet inflation time for pediatric patients (Pearson's chi-squared test= 5.776, SD=1, p=0.16).

Fifty-one participants (52%) stated that if there is bleeding despite intraoperative tourniquet use, there may be unsatisfactory initial cuff inflation pressure or increased blood pressure during surgery, or decreased tourniquet cuff pressure intraoperatively. Distribution of orthopedic residents' answers was statistically significantly different to the other groups (F=5.395, p=0.006). Forty-eight participants (49%) reported that they proceed with surgery without a tourniquet if there is a need to exceed safe tourniquet inflation time during surgery. Peripheral vascular disease, infection, malignancy, or sickle cell anemia history were reported as causes of complications by 21 participants (21.7%). Seventy-six participants (78.4%) chose all options for this question.

Discussion

An inflatable cuff, a compressed gas source, and a microprocessor-controlled pressure regulator that maintains cuff pressure are the main components of digital tourniquets, which have a monitor display showing cuff pressure and inflation time.[6] Additionally, there is an audiovisual alarm that is triggered by cuff leaks, excessively high or low cuff pressures, or prolonged tourniquet time.[6] Mechanical tourniquets have a pump to provide compressed gas, a mechanical monitor to display cuff pressure, and a connection attachment to the cuff. No orthopedic academic staff used mechanical tourniquet; orthopedic surgeons were the most common users of mechanical tourniquet in the survey.

The majority of participants (n=72, 73.5%) stated

that they use a plain cuff. However, reports in the literature detail the importance of contoured cuffs and how it may be impossible to obtain proper fit of the plain cuff on extremities of obese patients with limb tapering. Moreover, it is possible to use lower inflation pressures with contoured cuffs.[6–9] To be noted, use of a plain cuff is acceptable in appropriate cases. Wide cuffs have a more gradual pressure profile at all tissue depths, with peak pressures at the midposition of its width and lowest pressures at the periphery of the cuff.[10,11] Furthermore, wide cuffs require lower inflation pressures to stop the flow of arterial blood distal to the cuff.[6] There is an inverse relationship between limb occlusion pressure and the ratio of cuff width to limb circumference.[7] The width should be the widest possible but should not encroach upon the surgical site.[12] However, some studies have reported that narrower cuffs might result in less nerve damage during short term application.[13,14] Cuff length is important; it should be individualized according to the circumference of the patient's limb and should overlap at least 3 inches but not more than 6 inches to cause generation of high pressure.[15,16]

Institutional habits often determine which member of staff (personnel, nurse, surgeon, assistant) is responsible for tourniquet application.[17] Assistant (44.3%) and orthopedic theatre personnel (34%) were reported predominantly as responsible for tourniquet application. However, the surgeon is the person who is ultimately responsible for any consequences that may arise from tourniquet use.[15,18]

Tourniquet-related complications can be clinically devastating to the patient and may have significant medicolegal implications.[3,19,20] Most surgical trainees do not undergo formal training on tourniquet use; thus, most surgeons do not receive any education on proper tourniquet use either. However, it is advised that compulsory formal education regarding proper tourniquet use be given to all personnel every 6 months.[17] Consistent with the literature, 69.1% of participants had not received formal education about tourniquet use, and few participants (<4.1%) stated that they had received informal one-to-one training on tourniquet use.

Systemic complications are related to tourniquet inflation and deflation; however, local complications result from the direct effect of cuff compression and tissue hypoperfusion.[6,21] The most commonly reported complications are skin blistering, and muscle and nerve injury.[6,21] The combined effect of mechanical compression beneath the tourniquet and prolonged duration of ischemia is responsible for neuromuscular complications.[6,22] Soaking the cast padding with skin preparation solutions may cause chemical burns under the tourniquets.[15,23,24] Approximately 25% of participants reported that they have encountered one or more complications. Notably, more than 50% of academic staff reported complication experience, although this ratio was low in the other groups. The results suggest that orthopedic surgeons and residents may have a bias regarding this issue. Although orthopedic surgeons are aware of complications related to tourniquet usage, these problems may be neglected or escape observation due to intense working conditions.

Of participants, 78.6% reported that details of tourniquet use were recorded regularly. However, the rate of unrecorded details (21.4%) seems unacceptable. Appropriate records may be helpful in solving problems with potential medicolegal implications. Padding decreases shear stresses at the skin surface, and thus can prevent skin injuries.[25,26] Caution should be taken when using excessive padding, as it may reduce the efficiency of the tourniquet by increasing the limb circumference.[27] Most participants (94.9%) in the present study maintained padding recommendations as described in the literature. The tourniquet cuff should be applied in a location with adequate muscle mass, usually proximally, to protect nerves and vessels.[12,15] Responses in the survey about cuff placement localization were consistent with the literature (80.6% most proximally, 16.3% region of most muscle mass). Half of the participants in Group 3 reported that they applied the cuff in the region with the most muscle mass on the extremity ($F=5.530$, $p=0.005$).

There is no consensus on determination of optimum tourniquet pressure in extremities. The target is the lowest pressure that provides adequate tissue identification and visualization. There are many pressure setting methods used in clinical practice: fixed inflation pressure (typically 200–250 mmHg for upper arm and 300–350 mmHg for thigh), limb occlusion pressure (LOP) determination, arterial occlusion pressure estimation (AOPE), and fixed set pressure above systolic arterial pressure (systolic blood pressure plus 100 mmHg for upper arm and 100–150 mmHg for thigh).[12,21,28–30] We believe that determining the tourniquet pressure method should have a scientific basis and be simple, consistent, and expeditious. Scientifically valid options at lowest inflation pressure are LOP determination and AOPE methods.[6,12,21,30] These were not observed among the results at the expected rates, with academic staff even reporting 0% use. Traditional recommendations suggest parameters for maximum pressure rather than minimal effective pressure to achieve a bloodless field.[29] Controlled hypotension with decreased cuff inflation pressure is considerably important.[12,31] For LOP deter-

mination, a margin of error of 50–100 mmHg is added in consideration of dynamic conditions during surgery.[6,12,21] In children, a standard safety margin of 50 mmHg is recommended for all LOP determinations.[6,12,32,33]

Advantages of exsanguination of the extremity are establishing a clear operating field and reducing blood loss. Most survey participants (approximately 90%) preferred exsanguination of the extremity before tourniquet application, but there was no dominant exsanguination method chosen by the participants. The 3 main exsanguination methods were elevation, squeeze method, and Esmarch bandage. The most effective method is Esmarch bandage; however, both squeeze method and Esmarch bandage equally create a clear surgical field.[34,35] Simple elevation can achieve a good result where mechanical limb exsanguination is contraindicated,[6] with 5 minutes elevation appropriate for adequate exsanguination of limbs.[6,12]

Optimal time interval between antibiotic administration and tourniquet inflation is important for antibiotic prophylaxis, as efficiency of the prophylactic antibiotics requires tissue perfusion of the surgical site.[15,16] Antibiotic administration 5 minutes prior to tourniquet inflation has been reported as adequate to allow sufficient tissue perfusion, although antibiotics reach optimum tissue concentrations when they are administered 20 minutes prior to tourniquet inflation.[36–39] A 20–30 minute interval between antibiotic administration and tourniquet inflation was the most frequently chosen interval by survey participants (n=68, 69.4%).

There is no defined safe time period of tourniquet inflation for both upper and lower extremities.[6,21] Despite the wide interval of recommended times for both, the most commonly cited value is 120 minutes.[12,21] All attempts should be made to decrease tourniquet inflation time. Most survey participants stated they used 120 minutes inflation time for lower and 90 minutes for upper extremities (n=44, 44.9%). These values are consistent with the literature. There are few reports addressing proper tourniquet use in pediatrics, and less than 75 minutes of cuff inflation time for lower extremities in pediatric patients has been recommended.[32,40] However, only 38 participants' (39.2%) responses were consistent with the literature, according to tourniquet inflation time for pediatric patients with inflation time ≤75 minutes.

If tourniquet inflation time remains below 2 hours, after inflation of the cuff, histological, electrophysiological, and functional impacts of the tourniquet remain reversible.[13] It is possible to use the deflation and reinflation method after a set period.[12,16,21] In the method, readjustment of the interval is related directly to tourniquet time, and it is assumed that a 15–20 minute interval is acceptable for 120 minutes tourniquet time (the tourniquet should be deflated for 5 minutes for every 30 minutes of inflation time).[12,16,21] Proceeding with the surgery without tourniquet is a challenging option and was chosen by 48 participants (49%). Fifteen and 30 minute breaks between deflation and inflation of the tourniquet is consistent with the literature but were chosen by only 35 participants (35.7%).

If the surgeon encounters intraoperative bleeding with an inflated extremity tourniquet, he or she should consider underpressurized cuff, insufficient exsanguination (leakage), improper cuff selection, loosely applied cuff, and calcified vessels as possible causes.[12,31] Intraoperatively increased blood pressure should also be evaluated. Responses showed that approximately 50% of participants do not have sufficient clinical knowledge to overcome this worst-case scenario.

Seventy-six participants (78.4%) agreed with the literature regarding contraindications/relative contraindications. Use of Esmarch bandage is relatively contraindicated when treating either an infection or tumor.[21] Other contraindications are infection, open fracture, tumor distal to tourniquet, sickle cell anemia, previous revascularization of extremity, extremity with dialysis access, and venous thromboembolism.[6,12,15] In patients with arterial calcification, higher pressures are needed to obtain blood flow occlusion.[6]

Yalçınkaya et al.[5] recently reported a descriptive survey focused on pneumatic tourniquet utilization among orthopedic surgeons and residents in Istanbul, Turkey. However, the study has limitations that include lack of information about cuff type, education on tourniquet utilization, recording of details related to pneumatic tourniquet, cuff localization on extremity, arterial occlusion pressure estimation method to produce the lowest cuff pressure, relationship between antibiotic prophylaxis and tourniquet utilization, and worst-case scenarios (utilization of tourniquet for more than 2 hours and intraoperative bleeding despite tourniquet utilization). They investigated 2 groups consisting of orthopedic surgeons and residents; however, we investigated 3 groups: orthopedic surgeons, residents, and academic staff. The purpose of this demographic selection was to evaluate tourniquet utilization habits of academic staff and compare them with those of the other participants; this relationship is significant because the academic staff are in the position of educating others regarding proper tourniquet use.

Limitations of our study include the lack of information about systemic harmful effects of tourniquet

use, limited number of participants evaluated, lack of classification of intraoperative/postoperative and local/systemic complications, and lack of information on the orthopedic experience level of participants.

In conclusion, the results indicate that there is a wide variation in some aspects of tourniquet practice by participants in this pilot study. Although results were not totally inconsistent with the literature, the discrepancies found are not acceptable because of the significant complications that may result. This is a small sample group, but we believe it is representative of the greater orthopedic surgeon population in Turkey. Additionally, the Turkish Society of Orthopedics and Traumatology must further evaluate the level of knowledge regarding tourniquet use of orthopedic surgeons in Turkey with a larger survey. In our opinion, there is a need to provide and ensure adequate education to provide the best patient care, and protocols should be developed for acceptable practice standards of tourniquet use.

Conflicts of Interest: No conflicts declared.

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