ORIGINAL ARTICLE

A Survey of Tourniquet Use in Limbs Surgery among the Orthopaedic Surgeons of Peshawar

FAAIZ ALI SHAH, KHALID MAHMOOD, SHAHAB UD DIN, *WALI MOHAMMAD MEHSOD, ABDUL REHMAN QURESHI, IQTIDAR ULLAH BABAR*

ABSTRACT

Aim: To assess the orthopaedic surgeons knowledge and technique on tourniquet use in clinical practice in Peshawar.

Methods: This Descriptive case series study was conducted in Orthopaedic and Trauma Unit "A" Lady Reading Hospital Peshawar from February 2014 to July 2014. Fifty orthopaedic surgeons of Peshawar with varying levels of experience in Orthopaedics & Trauma surgery were given a questionnaire that was constructed using set guidelines from the Association of peri operative Registered Nurses (AORN) for recommended practice of tourniquet application in the United States.

Results: A total of 44 completed questionnaires were collected for analysis of which 34(77.2%) respondents were reported using pneumatic tourniquet, 6(13.6%) Esmarch bandage while, 4(9%) using no tourniquet at all. Limb occlusion pressure (LOP) or systolic blood pressure had not been utilized by any surgeon to calculate the tourniquet inflation pressure. Mean utes (range, 45-100 minutes) for the upper limb and 95 minutes for the lower limb. Fourteen surgeons (41.1% of respondents) using pneumatic tourniquet and four surgeons using rubber tourniquet experienced a complication secondary to tourniquet use, the most common complications being tourniquet pain and nerve injury.

Conclusion: Our results show suboptimal knowledge of tourniquets and their use among the orthopaedic surgeons of Peshawar. A variation in tourniquet pressure settings and techniques used was reported.

Keywords: Tourniquet, limb occlusion pressure, limb surgery.

INTRODUCTION

The term tourniquet derives from the French verb "tourner" that means to turn, and was coined by the French Surgeon Jean Louis Petit (1674–1750) who described a belt like device that was used to reduce blood loss in limb amputations. The belt was pulled tight around a limb with a screw sited over the main artery, and the screw subsequently turned to compress the artery[2]. In 1873, Esmarch described the use of a rubber bandage to exsanguinate the limb and application of a tourniquet made from rubber tubing.[3] Subsequent reports of tourniquet palsies and other complications related to the variable pressure and duration of tourniquet use called for attention.

The use of pneumatic tourniquets for surgery is credited to Harvey Cushing in 1904[4]. Tourniquet aids surgeons by providing a bloodless surgical field and thus facilitates identification of structures; thereby reducing operating time and reducing surgical complications[5]. Complications from tourniquet use are infrequent and preventable. However, when they do occur they can be clinically devastating to the patient and can have significant medicolegal implications[6].

Studies in Norway showed 26 complications in approximately 63,484 surgical procedures using tourniquets[7]. Tourniquet related nerve complications exist on a spectrum from minor transient loss of function to permanent irreversible damage. The incidence varies in the literature but nerve complications ranges from 1 in 750 to 1 in 11,000 in upper limb surgery. The radial nerve is most prone to injury[8,9,10]. Safe duration and pressure for tourniquet use remains a controversy. No strict guidelines have been laid down but studies have shown that significant ischemia and muscle dysfunction occurs after 2 hours[11]. However, simple principles and general guidelines regarding tourniquet use can be extrapolated to guide safe practice[12].

Tourniquets are commonly used in limbs surgery by Orthopaedic surgeons of Peshawar. But the use of tourniquet is mostly governed by individual practitioner preferences. To establish a standard practice guideline the current standard of care should be examined. Results from this study will help to improve the curriculum set out for trainee surgeons with regards to tourniquet use, and thus reduce the risk of adverse events.

Orthopaedics & Trauma Centre, Lady Reading Hospital Peshawar KPK,
Correspondence to Dr. Faaiz Ali Shah,
Email:faaizalishah@yahoo.com, Cell 03349125394

MATERIAL AND METHODS

This Descriptive case series study was conducted at Orthopaedic and Trauma Unit "A" Lady Reading Hospital Peshawar from February 2014 to July 2014.The study protocol was approval by the Ethics Committee of the hospital and a questionnaire was prepared using a set guideline from the Association of perioperative Registered Nurses (AORN)[1] for recommended practice of tourniquet application in the United States and was distributed among the Orthopaedic surgeons of Peshawar. Only qualified Orthopaedic surgeons (FCPS/FRCS) having at least three years of post fellowship experience and serving in private or government hospitals of Peshawar were included in the study. Seventeen survey questions assessed the surgeon's knowledge on tourniquet use and their potential complications (Table 1). Specific questions were asked about the type of tourniquet, pressure, location, and time limits. Respondents were asked whether they released the tourniquet temporarily during long operations and for how long they felt the interval should be. They were also asked to report any complications due to tourniquet use during the previous two years. Completed questionnaires were collected after one month from all the respondents. Data was analysed using SPSS version 16. Frequencies and percentages of all the variables were calculated and represented in table where necessary.

RESULTS

A total of 44 completed questionnaires were collected from Orthopaedic & Trauma surgeons of Peshawar for analysis. The average years in practice were 5.6 years (range, 3-30). Thirty four (77.2%) respondents were reported using pneumatic tourniquet, 6(13.6%) Esmarch bandage while, 4(9%) using no tourniquet at all. Tourniquet technique questionnaire results are shown in Table 1 in detail. In 70% (28 respondents) of cases usually the operating room assistants apply the tourniquet, set the pressure and remove it after the operation. But the surgeon was ultimately responsible for any consequences that arise from its use. Mean upper extremity pressure was 250mm (range, 150-300) while mean lower extremity pressure was 300mm (range, 200-400). Mean inflation time limit was 75 minutes (range,45-100 minutes) for the upper limb and 95 minutes(range,70-150 minutes) for the lower limb. Complications due to tourniquet were reported to be much higher in surgeons using Esmarch bandage tourniquet than pneumatic (66.6% versus 41.1% respectively).

Table 1: Tourniquet technique questionnaire results

Tourniquet Technique		Number of Respondents
Type of Tourniquet	A)Pneumatic	34(77.2%)
	B)Esmarch bandage	06(13.6%)
	C)None	04(9%)
Skin protection beneath tourniquet	A)Cotton	31(77.5%)
	B)Gauze	06(15%)
	C)None	03(7.5%)
Application of the tourniquet	A)By the surgeon	12(30%)
	C)By the assistant	28(70%)
Location of the tourniquet	A)Upper arm/Thigh	40(100%)
	B)forearm/Leg	00
Limb elevation before inflation	A)only elevation	35(87.5%)
	B)elevation+ Exsangination	05(12.5%)
Tourniquet repositioning	A)Yes	00
	B)No	40(100%)
Prevention of fluid/ blood leakagebeneath tourniquet cuff	A)Yes	00
	B)No	40(100%)
Reperfusion during prolonged tourniquet use	A)Yes	04(10%)
	B)No	36(90%)
Complications due to tourniquet	A)due to pneumatic	14(41.1%)
	B)due to rubber band	04(66.6%)
Know all contraindications to tourniquet use	A)Yes	12(30%)
	B)No	28(70%)
Document the use of tourniquet in patient's operation notes	A)Yes	15(37.5%)
	B)No	25(62.5%)
Decontamination/cleaning of tourniquet after each use	A)Yes	02(4.5%)
	B)No	42(95.4%)
Forgotten Tourniquet	A)Once or more	04(10%)
	B)Never	36(90%)
Regular checking of tourniquet valve and gauge/calibration	A)Yes	01(2.9%)
	B)No	33(97%)

The most frequent complication reported was tourniquet pain (68% Esmarch bandage, 32% pneumatic) followed by radial nerve palsy (58% in Esmarch bandage, 11% in pneumatic tourniquet) Nerve palsy spontaneously recovered within three months. Irreversible nerve damage has not been reported at all. No case of femoral or sciatic nerve palsy had been documented by the respondents. Blistering and skin necrosis was reported by 22% in esmarch bandage and 5% in pneumatic tourniquet. The most frequent cause of blistering of the skin is seepage of antiseptic solution into the padding beneath the cuff during skin preparation, resulting in a chemical burn as none of the respondents using skin protection padding to prevent fluid leakage beneath tourniquet cuff. Compartment syndrome or deep-vein thrombosis was not reported by any respondent. Tourniquet release allowing a reperfusion interval of 5 minutes, followed by re-inflation was practiced by only four (10%) surgeons. Only 12(30%) respondents knew all contraindications

to tourniquet use like in DVT, peripheral neuropathies, peripheral vascular disease, sickle cell disease, and Reynaud's disease. Documentation of the tourniquet use in patient's operation notes had been reported by 15(37.5%) respondents while 4(10%) surgeons forgot to remove the tourniquet (mostly esmarch bandage) after finishing the surgery once or twice in their practice in the past two years.

DISCUSSION

The evidence in the literature suggests that upper limb tourniquets are beneficial in promoting optimum surgical conditions and modern tourniquet use is associated with a low rate of adverse events[13]. In our study majority of the respondents 34(77.2%) were reported using pneumatic tourniquet while only 6(13.6%) using Esmarch bandage but complications due to esmarch bandage were higher than pneumatic tourniquet(66.6% versus 41.1% respectively). Non-pneumatic tourniquet devices typically produce applied pressures and pressure gradients that are significantly higher than the Limb Occlusion Pressure (LOP), and at levels associated with significantly higher rates of morbidity[13]. The outcome of the use of an Esmarch bandage for exsanguination and as a tourniquet in 112 consecutive patients who had elective orthopaedic operations on 131 limbs was evaluated at Obafemi Awolowo University Teaching Hospitals Complex, Nigeria, from March 2003 to February 2005. The duration of tourniquet application ranged from 20 min to 2h 35 min. Four limbs (3.1%) developed acute compartment syndrome; four (3.1%) had tourniquet paralysis with ulnar nerve involvement in three limbs. All limbs regained full neurological function following physiotherapy. The study concluded that in spite of its drawbacks, the Esmarch bandage is still useful for exsanguination and as a tourniquet in orthopaedic surgery where there is no pneumatic tourniquet[14].

Limb occlusion pressure (LOP) or systolic blood pressure had not been utilized by any surgeon in our study to calculate the tourniquet inflation pressure. Limb occlusion pressure (LOP) has been utilized to calculate the tourniquet inflation pressure by the AORN (Association of perioperative Registered Nurses)[1]. It is the pressure in the tourniquet at which the distal arterial blood flow, as assessed by a Doppler probe held over a distal artery, is occluded. This value is generally higher than the systolic blood pressure[15]. The AORN guidelines recommend that the tourniquet be inflated intraoperatively to a pressure higher than the LOP. A safety margin is added to cover intraoperative fluctuations in arterial pressure. If LOP is <130mmHg, the safety margin is 40mmHg; for LOP 131–190mmHg, the margin is 60 mm Hg; and if LOP is >190mmHg, the margin is 80mmHg[1] for pediatric patients, adding 50mmHg has been recommended[16].

None of our respondents had been using forearm tourniquet or calf tourniquet in our survey but there has been an increasing trend of using forearm tourniquets supported by literature evidence of their efficacy and safety[17]. Hutchinson and McClinton[18] had shown that, for minor surgical procedures under local anesthetic lasting less than 30min, patients reported less pain and tolerated tourniquets placed on the forearm better than those on the upper arm. Odinsson and Finsen[7] concurred with these findings but found that surgeons experienced greater difficulty with more distally placed tourniquets. A total of 199 survey responses collected through a website-based survey in a study reported mean lower extremity tourniquet pressure of 300 mm (range, 150-400), and mean upper extremity pressure of 250mm (range, 150-300). Less than 20% of respondents routinely used pressures of 250mm or less for the lower extremity. For upper extremity, only 11.3% used pressures at or below 200mm. The study concluded that tourniquet use is not benign and the correct pressure usage allows the least morbidity[19]. In another study ninety-two Irish orthopaedic consultants were sent a 15-survey question about tourniquet use by post. Thirty-nine surgeons (65% of respondents) use a tourniquet pressure range of 201-250 mmHg for the upper arm and 30 surgeons (50% of respondents) use a range of 251-300mmHg for the thigh. Thirty-six surgeons (60% of respondents) experienced a complication secondary to tourniquet use, the most common complications being nerve and skin injury. The study suggests that some of the tourniquet cuff inflation pressures used may be higher than necessary[20].

Mean tourniquet inflation time limit was reported to be 75 minutes (range, 45-100 minutes) for the upper limb and 95 minutes (range, 70-150 minutes) for the lower limb in our survey. The maximum permitted tourniquet time has been the subject of much debate. Noordin[21] stated that accurate monitoring and minimization of tourniquet time was the most important factor in preventing adverse events. Horlocker et al have found a strong correlation of nerve injury with prolonged total tourniquet time with an approximate threefold increase in risk of neurological complications for each 30 min increase in tourniquet inflation. The duration of uninterrupted tourniquet inflation also increased the likelihood of neural dysfunction[22]. Tourniquet should be inflated according to the LOP and should be deflated after 2 h for the lower limb and after 1½ h for the upper limb for at least 10 minutes[15].

The most frequent complication reported in our survey was tourniquet pain (68% Esmarch bandage, 32% pneumatic) followed by radial nerve palsy (58% in Esmarch bandage, 11% in pneumatic tourniquet) Nerve palsy spontaneously recovered within three months. Irreversible nerve damage has not been reported at all. No case of femoral or sciatic nerve palsy had been documented by the respondents. Although the pathophysiology of nerve injury associated with tourniquet use remains unclear, it is likely that both mechanical compression and neural ischemia play an important role[22]. Middleton and Varian[10] report one single case of femoral and sciatic nerve palsy after four and a half hours of tourniquet use. Due to prolonged use of the tourniquet, this nerve injury would not be rare in accordance with Horlocker et al[22] but this correlation is not supported by Odinsson and Finsen[7] as, on the basis of their questionnaire in Norway, most of the nerve complications occurred after the tourniquet had been inflated for less than two hours at a pressure of 300mmHg or less. Majority 42(95.4%) of orthopaedic surgeons in our study were not decontaminating or cleaning the tourniquet after each use. Tourniquet contamination may be a risk factor for the development of surgical site infection in orthopaedic surgery as 80% of re-usable tourniquets were colonised with maximum colonies of coagulase-negative Staphylococcus spp. and Bacillus spp[23]. Another study reported contamination of 68% of orthopaedic surgical tourniquets which were used regularly in procedures involving the placement of prosthesis and metalwork, and could act as a potential source of infection and the study recommend the use of sterile single-use disposable tourniquets where possible[24]. As most hospitals do not have a protocol for cleaning tourniquets, Ahmad[25] had found a 99% reduction in contamination of tourniquets by employing disinfectant wipes. This is a simple, cost-effective and quick method to clean the tourniquets and he recommends the use of wipes before every case in addition to the manufacturers' guidelines for cleaning the tourniquet.

CONCLUSION

Our results show suboptimal knowledge of tourniquets and their use among the Orthopaedic surgeons of Peshawar. A variation in tourniquet pressure settings and techniques used was reported. Guidelines for optimizing cuff pressure and technique should be established to minimize the risk of complications. This survey highlighted the need for amendments in training to improve the knowledge and awareness to prevent adverse events.

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