Original Article

Comparison between Fixed Tourniquet Inflation Pressure and Limb Occlusion Pressure in Children Undergoing Corrective Osteotomy for Blount's Disease

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Abstract

Background: A tourniquet is commonly used to achieve a clear operative field during corrective osteotomies for Blount's disease in children. Excessive tourniquet pressures may, however, lead to complications that may threaten the child's limb, causing avoidable morbidity. Determining the minimum effective cuff pressure required to achieve a bloodless field without causing any harm to the child's limb becomes essential to good surgical practice. **Objectives:** To compare the effectiveness of and the complications arising from the tourniquet between fixed inflation pressure (FIP) and pressure determined by limb occlusion pressure (LOP) in children undergoing corrective osteotomy for Blount's disease. **Materials and Methods:** Fifty lower limbs of 50 children aged 5–17 years who were undergoing corrective osteotomy for Blount's disease were randomised into two groups (A and B) of 25 each. Group A is the LOP, whereas Group B is the FIP group. The tourniquet pressure, quality of the clear operative field, local tourniquet complications of pain, skin damage and nerve palsy were compared between the groups. Tourniquet pressure, effectiveness, complications, corrective osteotomy and Blount's disease between the groups. Data were analysed using IBM SPSS statistic version 23. **Results:** The mean age of the population was 7.2 years. There was a significant mean decrease of pressure of 82 mmHg in Group A compared to Group B. Both groups had similar quality of the bloodless field; however, there were significantly less complications in Group A. **Conclusions:** LOP method performs better than the fixed pressure method. It achieves a comparable bloodless field while having a better safety profile.

Keywords: Blount's disease, complications, corrective osteotomy, effectiveness, tourniquet pressure

Introduction

A tourniquet is a constricting or compressing device that is used to control arterial or venous circulation to an extremity for a period of time.[1] A tourniquet is used in orthopaedics and trauma surgery to create a bloodless field, which improves the surgeon's visualisation and speed as well as dexterity.[2] Other uses of the tourniquet include intravenous regional anaesthesia (biers block), isolated limb perfusion in the treatment of localised tumour, and in the treatment of complex regional pain syndrome.[3] A tourniquet may also be used for the emergency control of exsanguinating haemorrhage as during war times where injuries from gunshots and other explosives may lead to death from uncontrolled bleeding.[4,5]

Tourniquet may be inflatable (pneumatic) or Esmarch types. The modern tourniquet is a pneumatic device consisting of an inflatable cuff connected by tubing to a compressed gas supply. The pressure generated can be measured, thereby allowing controlled arterial compression.[6] This makes the pneumatic tourniquet potentially safer than the Esmarch type.[7]

Regardless of the type of tourniquet local complications can arise following its use if the cuff pressure is too high and/or if the tourniquet duration is too long. These complications may

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be devastating for the patient, and may result in avoidable medico-legal challenges for the surgeon.[8-10] Excessive tourniquet pressure can damage the skin, muscles, nerves and vessels beneath the cuff, resulting in pain, nerve palsy or skin blistering or necrosis. It is, therefore, recommended that the minimum effective cuff pressure required to achieve a bloodless field be used to avoid such complications.[11-13]

It is a common practice to inflate the cuff to a fixed pressure, usually 250 mmHg for the upper limb, and 300 mmHg for the lower limb. Alternatively, other surgeons commonly practice inflating the cuff to a fixed pressure above the systolic blood pressure (100 mmHg for the upper limb and 150 mmHg for the lower limb). Neither of the above practices is ideal, as either may result in excessive cuff pressure being applied. The minimum effective cuff pressure that achieves a bloodless field is always advocated.[14-16]

The gold standard for determining the minimum effective cuff pressure required to achieve a bloodless field is the use of limb occlusion pressure (LOP) or arterial occlusion pressure. This is the minimum pressure required to stop the flow of arterial blood distally when a specified cuff is applied in a specific location of a limb at a specific time.[17] LOP is measured when the cuff pressure is gradually increased until there is the absence of flow distally as detected by the pulse oximeter or the Doppler stethoscope.[18] Furthermore, some automated tourniquets have in-built plethysmographic systems that record the LOP as the cuff is inflated. The use of LOP in determining the minimum effective cuff pressure has led to cuff pressures decreasing by 20%–40% in adults, and over 50% in children.[19] The optimum pressure required to occlude distal arterial flow in a limb is dependent on the patient's age, systolic blood pressure, the shape and size of the involved extremity, as well as the dimensions of the cuff.[20]

Data from our environment are lacking on this subject as very few studies to our knowledge have been conducted on this from Nigeria. This study was therefore done to compare the effectiveness of using LOP versus fixed inflation pressure (FIP) in achieving a bloodless operative field. Furthermore, the local complications from their use were compared. It is hoped this will provide guidance in safe tourniquet use in orthopaedic surgery practice generally.

Materials and Methods

This was a prospective randomised study carried out at the National Orthopaedic Hospital, Igbobi Lagos, Nigeria, over 12 months. The National Orthopaedic Hospital is a Tertiary Specialist Hospital that provides orthopaedics and plastic surgery services to Lagos state and its environment.

The Ethical Committee Clearance of the hospital was sought and obtained with a certificate number OH/90/C/IX issued on 23rd October 2019. Also informed consent for corrective osteotomy as well as for enrolment into the study was obtained from the parents of all enrollees for the study. Assent for the study was obtained from those who were 7 years and above.

Enrollees were patients aged 5–17 years who had genu varum deformity due to Blount's disease and were billed for corrective osteotomy and in whom tourniquet was indicated, whose parents gave consent for the study. Those who were below 5 or above 17 years, those whose parents declined consent, as well as those in whom tourniquets were contra-indicated were excluded from the study. Furthermore, those whose tourniquet time exceeded 2 h were excluded.

The sample size was estimated using the Taro Yamane formula for proportions:

$n = N/1 + N \times (e)^2$

n = desired sample size

N = estimated population size = number of patients with Blount's disease that underwent corrective osteotomy in whom tourniquet was used at National Orthopedic Hospital Igbobi, Lagos (NOHIL) in the last 1 year = 55

e = accepted sampling error = 5% = 0.05; assuming 95% confidence level and $P = 0.05$

$n = 55/1 + 55 \times (0.05)^2$

$n = 55/1 + 55 \times 0.0025$

$= 55/1 + 0.1375 = 48.352$

Assuming an attrition rate of 5% = 2

$n = 48 + 2 = 50$ limbs

Thus, 25 limbs each were randomly assigned to both Groups A and B.

Subjects were recruited from the two paediatric outpatient clinics of the NOHIL. Randomisation was by simple ballot technique. Fifty equal-sized, similarly coloured, sealed opaque envelopes were placed in an opaque box. Twenty-five of them contained cards labelled A representing the LOP group (Group A), whereas the other 25 contained cards labelled B representing the FIP group (Group B). Each subject was made to pick a single envelope from the box, which was not returned to the box until all the subjects had been so assigned to the study groups. Each assigned patient was then identified by their hospital numbers.

A Riester 5255 manual pneumatic tourniquet with a hand pump and a pressure gauge was used for the study. Furthermore, the pulse oximeter used was a Facelake FL400 to confirm LOP. All measurements were carried out by author 1 who also applied all the tourniquets with the help of a trained assistant. All surgeries were carried out by the unit consultant.

Each subject's blood pressure was recorded after the induction of anaesthesia and before the measurement of the LOP.

Tourniquet application

The tourniquet was fully deflated before each application. It was applied over the mid-thigh after ensuring the skin was normal and adequately padded by four layers of soft band. An adhesive tape was wrapped around the distal edge of the

tourniquet to prevent the seepage of cleaning solutions under the tourniquet during skin preparation by the surgeon.

For patients in Group A

The LOP was determined while the patient lay supine with the limb fully extended over the theatre table. The pulse oximeter was then attached to the big toe and the reading was noted. The tourniquet was then gradually inflated until no reading was recorded by the pulse oximeter. The pressure at which the reading so disappears was noted. The cuff was then inflated a further 50 mmHg and gradually deflated until the oximeter again picks up the reading. Again, the pressure at which the reading reappears was recorded. The average was then taken for each subject to be the LOP.

With the limb fully prepared and draped free and prophylactic antibiotic given, the limb was exsanguinated by being elevated 45° for 5 min. The cuff was then inflated to the predetermined LOP plus an additional 50 mmHg. Tourniquet inflation time was noted and announced every 30 min by the anaesthetist. At the end of surgery, the tourniquet time was noted and it was deflated completely and removed. The soft band was also removed and skin over the mid-thigh was massaged for patients comfort.

For patients in Group B

With the limb fully prepared and draped free and prophylactic antibiotics given, the limb was exsanguinated by being elevated 45° for 5 min. The cuff was then gradually inflated to a fixed pressure of 250 mmHg. Time of inflation was noted, and tourniquet time was announced at intervals of 30 min by the anaesthetist. Tourniquet time at the end of surgery was also noted and documented. The cuff was then deflated and removed. The soft band was also removed, and the skin over the mid-thigh was massaged for patients comfort.

Assessment

The tourniquet effect in achieving a bloodless operative field was assessed by the operating surgeon, who was blinded to the groups using the Linkert Scale:

- Excellent = 1 (completely bloodless)
- Good = 2 (some blood but no interference with the surgery)
- Fair = 3 (some blood with some interference with the surgery).

Pre- and post-operative (day 1) packed cell volume (PCV) were documented.

Complications were assessed by an assistant who was also blinded to the groups 6 h post-operation and on day 1 post-operation. Skin damage was determined as follows:

- No skin damage = 0
- Erythema = 1
- Bruises = 2
- Abrasion = 3
- Bullae/skin necrosis = 4.

Tourniquet site pain was determined by asking the patient and if present severity was determined by the Visual Analogue Scale.

Nerve injury was determined by the presence of weakness in any of the muscles of the leg.

Data analysis

Data were collected using a structured pro forma from which they were entered into IBM SPSS version 23 Chicago, Illinois, USA for sorting and analysis. Results are presented in figures and tables as appropriate. All categorical data were compared using the Chi-square test, whereas continuous variables were compared using Student's *t*-test, and values <0.05 were considered statistically significant.

Results

Fifty subjects were enrolled from 63 patients who were seen during the study period. Seven of the 13 who were not enrolled declined consent, while the other six did not meet the inclusion criteria [Figure 1].

Amongst those recruited for the study, 21 (42%) were male while 29 (48%) were female giving a male:female ratio of 1:1.4 [Figure 2].

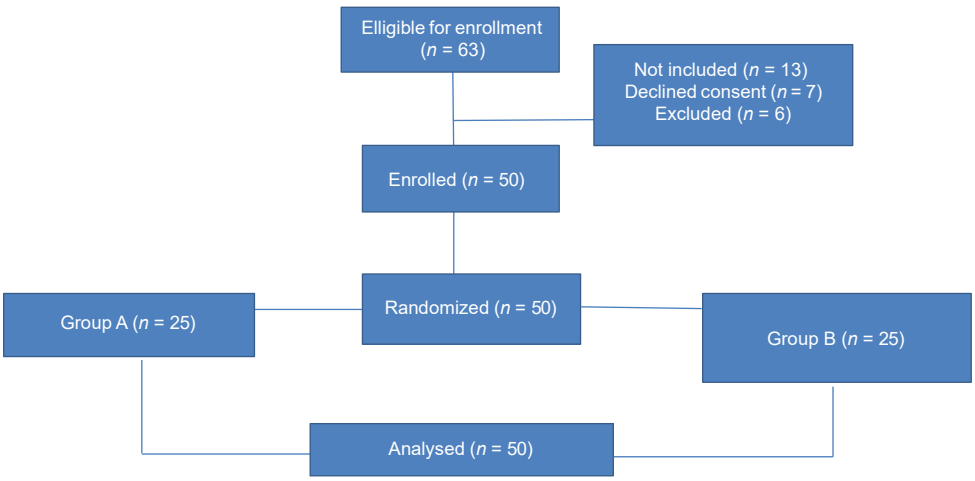


Figure 1: Flow chart for study participants

The mean age of the subjects was 7.2 ± 2.75 years, with a range of 5–15 years. The mean weight of the subjects in kilogram was 36.30 ± 5.537 kg, whereas the mean height in centimetres was 116.66 ± 12.761 cm [Table 1].

Pre-operative parameters in the groups

Gender

amongst Group A subjects, 11 (44%) were male and 14 (56%) were female, whereas in Group B, 13 (52%) were male and 12 (48%) were female. This was not statistically different at $P = 0.571$.

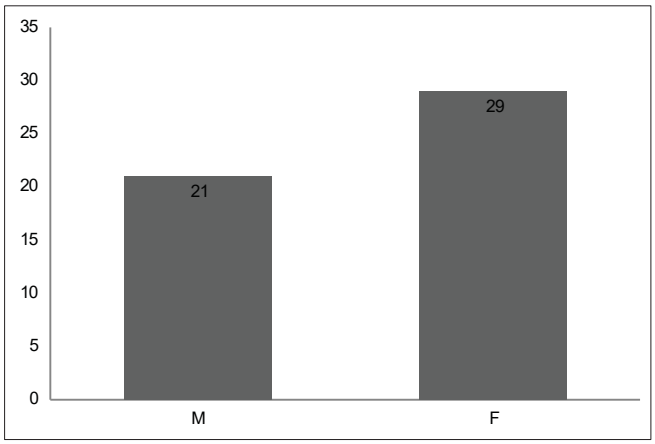


Figure 2: Gender distribution of study participants

Table 1: Descriptive statistics of age, weight, and height of participants

Descriptive statistics of all the respondents	Age (years)	Weight (kg)	Height (cm)
Mean	7.20	36.30	116.66
Median	6.00	35.00	111.00
Mode	5	33	109
SD	2.748	5.537	12.761
Minimum	5	28	104
Maximum	15	51	151

SD: Standard deviation

Laterality

Sixteen (64%) of the surgeries were on the right leg, while 9 (36%) were on the left leg amongst Group A subjects. In group B subjects , there were seventeen (68%) surgeries on the right leg and eight (32%) on the left leg. There were more surgeries done on the right leg than on the left, but this was not statistically different between the groups ($P = 0.765$).

Weight

The mean weight was 35.52 ± 5.2 kg in Group A, while it was 37.08 ± 5.86 kg in Group B. This was not significant at $P = 0.324$.

Packed cell volume

The mean PCV was 37.44% ± 2.06% in Group A, while it was 37.56% ± 2.99% in Group B, which was not significantly different at $P = 0.869$.

Systolic blood pressure

The mean preoperative blood pressure was 111.76 ± 4.23 mmHg in Group A, while it was 110.00 ± 5.65 mmHg in Group B with no statistical difference at $P = 0.217$. Preoperative parameters in the groups Gender Table 2.

Perioperative parameters in the groups

Tourniquet pressure

The mean tourniquet pressure in Group A was 168 ± 2.4 mmHg as against 250 mmHg in Group B, which showed a marked statistically significant difference at $P = 00001$ [Figure 3].

Packed cell volume

The mean post-operative PCV was 34.44% ± 2.123% in Group A, while it was 33.76% ± 2.332% [$P = 0.286$, Table 3].

Effectiveness of the tourniquet (bloodless field)

Fifteen (60%) of Group A, as against 17 (68%) of Group B had excellent operative field, while 10 (40%) in Group A and 8 (32%) in Group B had good operative field, which was not statistically different at $P = 0.568$ [Table 4].

Tourniquet time and local complications

The mean tourniquet times were 56.68 ± 4.2 min in Group A and 59.76 ± 6.48 min in Group B, which shows no significant difference at $P = 0.06$.

Table 2: Pre-operative parameters of study groups

Pre-operative parameters	Group		χ^2	P
	A (n=25), n (%)	B (n=25), n (%)		
Sex				
Male	11 (44.0)	13 (52.0)	0.321	0.571
Female	14 (56.0)	12 (48.0)		
Limb operated on				
Right	16 (64.0)	17 (68.0)	0.089	0.765
Left	9 (36.0)	8 (32.0)		
Weight (kg)	35.52±5.20	37.08±5.86	0.996	0.324
Height (cm)	114.64±11.25	118.68±14.05	1.122	0.267
Pre-operative PCV (%)	37.44±2.06	37.56±2.99	0.165	0.869
Pre-operative systolic BP (mmHg)	111.76±4.23	110.00±5.63	−1.252	0.217

PCV: Packed cell volume, BP: Blood pressure

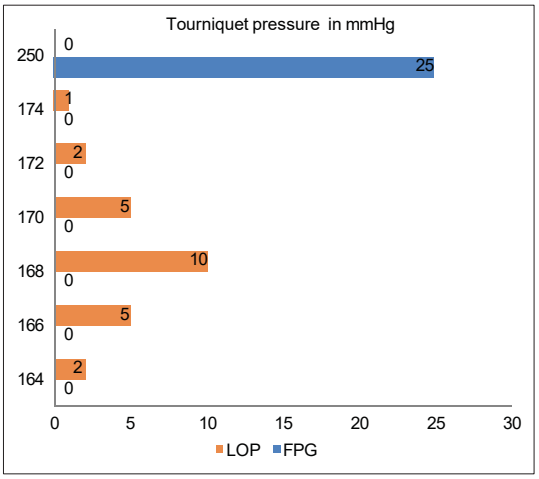


Figure 3: Tourniquet pressures in both groups: Limb occlusion pressure = Group A, FIP= Group B. FIP: Fixed Inflation Pressure, LOP: Limb occlusion pressure

Table 3: Paired *t*-test of the packed cell volume of both groups

Indices	Group A	Group B	*T*	*P*
Pre-operative PCV	37.44±2.063	37.56±2.987	0.165	0.415
Post-operative PCV	34.44±2.123	33.76±2.332	1.078	0.286
Paired *t*-test	13.238	10.97		
P	0.0001	0.0002		

PCV: Packed cell volume

Table 4: Assessment of bloodless field

Operative field	Group		χ^2	*P*
	A (*n*=25), *n* (%)	B (*n*=25), *n* (%)		
Excellent	15 (60.0)	17 (68.0)	0.347	0.568
Good	10 (40.0)	8 (32.0)		

Table 5: Independent *t*-test analysis of tourniquet time and complications in both groups

Pre-operative parameters	Group		χ^2/t*	*P*
	A (*n*=25), *n* (%)	B (*n*=25), *n* (%)		
Tourniquet time	56.68±4.2	59.76±6.48	1.992*	0.06
Pain	6 (24.0)	18 (72.0)	11.538	0.001
No pain	19 (76.0)	7 (28.0)		
Skin damage	0	6 (24.0)	6.818	0.009
No skin damage	25 (100.0)	19 (76.0)		
Nerve damage	0	0	-	-
Wound infection	0	0	-	-

*Significance at *P*=0.001

Tourniquet site pain was observed in only 6 (24%) subjects in Group A as against 18 (72%) in Group B, which was significant at $P = 0.001$ [Table 5]. All six subjects (24%) who had skin damage were in Group B, none in Group A [$P = 0.009$, Table 5]. No subjects in both groups had nerve damage or wound infection [Table 5].

Discussion

The goal of using a tourniquet in limb surgery, especially during corrective osteotomy in children with Blount's disease, is to achieve a bloodless operative field, which enables the surgeon to have a clearer view of the operative field, thereby enhancing his speed and dexterity. This must, however, be achieved at minimal cost to the local tissues, which might be damaged if the tourniquet pressure is too high or applied for too long duration.

It is our finding that the use of LOP to determine tourniquet pressure for each individual patient undergoing corrective osteotomy for Blount's disease achieves both goals of having a bloodless operative field at optimum cuff pressure, resulting in little or no local tissue damage. This results in significantly lower cuff pressures being used for each individual patient.

In our study, the mean age was 7.2 years, slightly lower than the 9.7 years reported by Kawu *et al*.[21]

This probably may reflect increasing awareness amongst the population resulting in earlier presentation now than it used to be. The mean age in both studies also supports the fact that Blount's is indeed a disease of children.

Our study reveals that even at a reduced mean cuff pressure of 168 mmHg (a mean decrease of 82 mmHg), we could achieve a comparable bloodless operative field with less complications to local tissues as compared to a fixed cuff pressure of 250 mmHg that is commonly used. This has the added advantage of individualising the cuff pressure needed for the specific patient whose LOP might differ from that of another. In a similar study, Lieberman *et al*.[22] reported the minimum effective pressure by LOP of 177 mmHg. The slight difference between theirs and our findings may be due to slight differences in the demographic characteristics of the groups studied. Contrariwise, Rielly *et al*.[23] found a lower mean LOP of 151 mmHg than we found. This may be attributable to differences in the cuff diameter; they used a wider cuff than in our study. Pedowitz *et al*.[24] and Younger *et al*.[25] both showed in their studies that the use of wide and contoured cuffs leads to occlusion at lower pressures than when straight, cylindrical or narrow cuffs are used.

We found that local tourniquet complications were more in the fixed pressure group than in the LOP group. This suggests a better safety profile when LOP was used to determine cuff inflation pressure. Local tourniquet site pain and skin damage both occurred significantly more, $P = 0.001$, $P = 0.009$, in the fixed pressure group. Png *et al*.[26] found in a similar study done on patients undergoing total knee replacement that the use of LOP to determine cuff inflation pressure resulted in a significantly reduced incidence of post-operative thigh pain. The overall incidence of tourniquet site pain in our study was 24 (48%): 6 (24% in group A) and 18 (72% in Group B). Kamath *et al*.[27] found the incidence of tourniquet site pain in surgery of the lower limbs lasting <60 min to be 7.7%, which is much lower than what we found. The discrepancy may relate

to the differences in the demographics, sample size and cuff size used in their study.

Conclusions

It is the findings of our study that the use of LOP to determine tourniquet pressure results in significantly lower cuff pressure with comparable bloodless operative field but with fewer complications than when fixed cuff pressure was used.

Recommendations

We recommend the use of LOP in determining tourniquet pressure in extremity surgery as it offers lower cuff pressures adapted to individual characteristics and a better safety profile. A multicentre study will increase the strength of this recommendation.

Limitations

The subjective nature of the Linkert Scale used to assess the quality of intra-operative bloodless field may affect the assessment. However, the fact that the surgeon who did the assessment was blinded to the groups helped to improve this rating scale.

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Conflicts of interest

There are no conflicts of interest.

References

1. Olivecrona C, Lapidus LJ, Benson L, Blomfeldt R. Tourniquet time affects postoperative complications after knee arthroplasty. Int Orthop 2013;37:827-32.
2. Saied A, Ayatollahi Mousavi A, Arabnejad F, Ahmadzadeh Heshmati A. Tourniquet in surgery of the limbs: A review of history, types and complications. Iran Red Crescent Med J 2015;17:e9588.
3. Murphy CG, Winter DC, Bouchier-Hayes DJ. Tourniquet injuries: Pathogenesis and modalities for attenuation. Acta Orthop Belg 2005;71:635-45.
4. Farhan-Alanie MM, Dhaif F, Trompeter A, Underwood M, Yeung J, Parsons N, *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.
5. Kragh JF Jr., Walters TJ, Baer DG, Fox CJ, Wade CE, Salinas J, *et al.* Survival with emergency tourniquet use to stop bleeding in major limb trauma. Ann Surg 2009;249:1-7.
6. Chrystelle S, Mamadou MT, Julien P, Lucie C, Jeremie C, Marion D, *et al.* Pneumatic tourniquet in paediatric orthopaedic surgery-is it not time to break the pressure of habits? Clin Surg 2019;4:2692.
7. Odinsson A, Finsen V. Tourniquet use and its complications in Norway. J Bone Joint Surg Br 2006;88:1090-2.
8. Cunningham L, McCarthy T, O'Byrne J. A survey of upper and lower limb tourniquet use among Irish orthopaedic surgeons. Ir J Med Sci 2013;182:325-30.
9. 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. Dragosloveanu S, Dragosloveanu C, Petre M, Gherghe ME, Cotor DC. The impact of tourniquet usage on TKA outcome: A single-center prospective trial. Medicina (Kaunas) 2023;59:870.
11. Kumar K, Railton C, Tawfic Q. Tourniquet application during anesthesia: "What we need to know?" J Anaesthesiol Clin Pharmacol 2016;32:424-30.
12. Olivecrona C, Ponzer S, Hamberg P, Blomfeldt R. Lower tourniquet cuff pressure reduces postoperative wound complications after total knee arthroplasty: A randomized controlled study of 164 patients. J Bone Joint Surg Am 2012;94:2216-21.
13. McEwen JA. Complications of and improvements in pneumatic tourniquets used in surgery. Med Instrum 1981;15:253-7.
14. 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.
15. Jensen J, Hicks RW, Labovitz J. Understanding and optimizing tourniquet use during extremity surgery. AORN J 2019;109:171-82.
16. Sharma JP, Salhotra R. Tourniquets in orthopedic surgery. Indian J Orthop 2012;46:377-83.
17. Cox C, Yao J. Tourniquet usage in upper extremity surgery. J Hand Surg Am 2010;35:1360-1.
18. Levy O, David Y, Heim M, Eldar I, Chetrit A, Engel J. Minimal tourniquet pressure to maintain arterial closure in upper limb surgery. J Hand Surg Br 1993;18:204-6.
19. Sato J, Ishii Y, Noguchi H, Takeda M. Safety and efficacy of a new tourniquet system. BMC Surg 2012;12:17.
20. Bruner JM. Time, pressure, and temperature factors in the safe use of the tourniquet. Hand 1970;2:39-42.
21. Kawu AA, Salami OO, Olawepo A, Ugbeye MA, Yinusa W, Odunubi OO. Outcome analysis of surgical treatment of blount disease in Nigeria. Niger J Clin Pract 2012;15:165-7.
22. Lieberman JR, Staheli LT, Dales MC. Tourniquet pressures on pediatric patients: A clinical study. Orthopedics 1997;20:1143-7.
23. Reilly CW, McEwen JA, Leveille L, Perdios A, Mulpuri K. Minimizing tourniquet pressure in pediatric anterior cruciate ligament reconstructive surgery: A blinded, prospective randomized controlled trial. J Pediatr Orthop 2009;29:275-80.
24. Pedowitz RA, Gershuni DH, Botte MJ, Kuiper S, Rydevik BL, Hargens AR. The use of lower tourniquet inflation pressures in extremity surgery facilitated by curved and wide tourniquets and an integrated cuff inflation system. Clin Orthop Relat Res 2016;32:4:424-3.
25. Younger AS, Kalla TP, McEwen JA, Inkpen K. Survey of tourniquet use in orthopaedic foot and ankle surgery. Foot Ankle Int 2005;26:208-17.
26. Png W, Lee W, Tan MH. Lower tourniquet cuff pressure reduces post-operative thigh pain in obese patients undergoing total knee arthroplasty. Int J Res Orthop 2019;5:1-8.
27. Kamath K, Kamath SU, Tejaswi P. Incidence and factors influencing tourniquet pain. Chin J Traumatol 2021;24:291-4.