Journal of Orthopaedics 23 (2021) 233–238

Contents lists available at ScienceDirect

Journal of Orthopaedics

journal homepage: www.elsevier.com/locate/jor

Visualization in arthroscopic meniscectomy– portal-site injection versus tourniquet inflation: A prospective, double-blinded, randomised controlled study

Prateek Kumar Gupta [a,*], Vishesh Khanna [b], Ashis Acharya [a]

[a] Department of Sports Medicine, Sir Ganga Ram Hospital, New Delhi, India
[b] Wrighitngton Wigan and Leigh NHS Foundation Trust, UK

ARTICLE INFO

Keywords:
Arthroscopic meniscectomy
Tourniquet
Portal-site injections
Comparative visualization
Randomised controlled study

ABSTRACT

Objectives: Alternatives to tourniquets include portal-site epinephrine injections. This prospective, randomised-controlled, double-blinded study compared intraoperative visibility and safety of portal-site injections with tourniquets in arthroscopic meniscectomies.
Methods: Sixty eligible adults [16-55ys, excluding vascular/neuromuscular/systemic illnesses] were randomly/equally divided across 3 groups A (controls)-local portal injections; B-local injections with tourniquet; C-local and 1:200,000epinephrine injections. A single surgeon operated blinded to patient group. Intraoperative visibility, surgeon visual analogue score (VAS)and other details were recorded.
Results: Superior visibility [p = 0.003,p = 0.027] and VAS [p = 0.010,p = 0.042] were reported in groups B, C versus A, Visibility [p = 0.705; p = 0.805] and operating times [p = 0.05] were comparable between B and C.
Conclusions: Portal-site epinephrine injections emerged as tenable surrogates for tourniquets for clear visualization in arthroscopy.

1. Introduction

With increasing awareness, broader indications and improved tutelage, arthroscopy has grown over the last 40 years to emerge as one of the most common orthopaedic procedure to be performed in Europe.

Arthroscopic meniscectomy is a minimally invasive, low-morbidity surgery that has been familiarised because of upgraded instrumentation and techniques, as well as widespread arthroscopic training. Over the last few decades, routine use of pneumatic tourniquets in arthroscopic knee surgery for unclouded, blood-free surgical field visibility and shortened operative time, has allowed surgeons to achieve higher diagnostic yields and therapeutic efficacies.[1]

Despite its unprecedented use in knee arthroscopy by over 90% of surgeons in the United Kingdom, several complications have been reported after its application including thigh pain, swelling and stiffness, skin abrasion, ulcerations and chemical burns, vascular, muscle and nerve injuries, metabolic and temperature changes, reperfusion syndrome, thromboembolism, cardiorespiratory decompensation and arrest with exsanguination.[2–4] Many have, therefore, questioned whether the potential benefits outweigh the added risks with a tourniquet and have sought alternatives to tourniquet-assisted arthroscopy.[4–12]

Among others, dilute epinephrine saline irrigation has been documented to serve as a reliable substitute to the tourniquet.[13–15] However, controlled studies have observed chondrotoxicity of epinephrine-containing local anaesthetics when used through intra-articular pumps.[16] Additionally, statistically significant changes in haemodynamic parameters have been observed in patients undergoing arthroscopy receiving intra-articular epinephrine with bupivacaine.[17]

Much of the bleeding in arthroscopy has been shown to arise from portal incisions.[17] Injecting this area with epinephrine has been shown to be a safe and effective tool in obtaining a clear intraoperative view.[17] There is no reported study to date in literature, to the best of our knowledge, comparing arthroscopic procedures performed with tourniquet and portal-site (PS) injection of lignocaine with epinephrine (PILE) as modalities of achieving bloodless surgical field with a control population.

In order to bring ourselves in line with the current practice, it was decided to conduct a prospective, randomised, double-blinded study comparing the use of a tourniquet and PILE with a control population receiving neither for routine arthroscopic meniscectomies. The aim of

* Corresponding author.
E-mail address: sportsmedicineresearch@gmail.com (P. Kumar Gupta).

https://doi.org/10.1016/j.jor.2021.01.015
Received 15 July 2020; Received in revised form 20 October 2020; Accepted 30 January 2021
Available online 4 February 2021

the present study was to compare and analyse these three groups in terms of intraoperative visibility by the number of flushes required, surgeon visual analogue scale (S-VAS), duration of surgery and effects on the mean arterial pressure (MAP) and heart rate (HR) intraoperatively. It was hypothesised that PS injections would be able to offer comparable (if not better) visibility versus tourniquet application for arthroscopic meniscectomy.

2. Materials and methods

This research was conducted at a tertiary care teaching centre, as a prospective, randomised and double-blinded study from October 2015 to October 2016 after obtaining a prior ethics committee approval (vide number EC/04/15/810). The committee thoroughly reviewed the study protocol, patient information sheets, informed consent forms, and evaluation forms. These were all found to be appropriate and were approved from an ethical angle. The informed consents for the purpose of this study had the study title written on them which mentioned its "controlled", "randomised" and "blinded" nature. Additionally all words of this were elaborately explained to each patient who were aware about the important specifics of the project.

Patients between the ages of 16 and 55, undergoing arthroscopic partial meniscectomy for symptomatic meniscal tears (simple radial, longitudinal and horizontal) were included. Complex degenerative tears, bucket-handle, parrot beak, flap tears and root avulsions were excluded to avoid bias creeping from prolonged surgical time and complexity. Those with pre-existing joint space narrowing (osteoarthritis/rheumatoid arthritis) vascular, neuromuscular, or systemic illnesses, previous surgery to injured or contralateral knee, anterior or posterior cruciate ligament injury requiring reconstructive surgery or hypersensitivity to lignocaine were also excluded. Patients were randomly distributed into 3 groups namely: group A (controls) who were to receive PS injections of 2% lignocaine only, group B receiving PS injections of 2% lignocaine along with tourniquet application, and group C where PS lignocaine injections were administered with 1:200,000 epinephrine (PILE). Portal sites were injected locally with 2% lignocaine in all patients as per protocol in our institution to allow postoperative pain relief and also for standardization for easier comparison across all three groups. The anaesthetist was requested to randomly select a sealed slip, from a box containing 60 such slips, for the respective patient and to disclose to the non-scrubbing assistant whether the patient belonged to group A, B or C. All surgeries were carried out under general anaesthesia following identical anaesthetic protocols. The scrub nurse was instructed to load a 10 ml syringe the contents of which were determined by the group allotted to the patient. In case of groups A and B, the syringe had 10 ml of 2% lignocaine, while for group C the syringe was to contain 10 ml of 2% lignocaine solution with 1:200,000 epinephrine. All injections were made only into the portals and not intraarticularly. This was ensured as the injections were subcutaneous in depth and penetration with careful insertion technique including aspiration before injection to confirm absence of synovial fluid. Any evidence of intraarticular penetration (give-way of needle) were corrected and carefully re-attempted.

The tourniquet was applied over the proximal thigh in all cases and inflated, for group B cases only, to (100–150 mm Hg higher than the systolic pressure) after elevation of the prepared limb for 3 min.

The surgeon entered the operation theatre at this stage and was blinded to the group of the patient and consequently to the tourniquet status. He was therefore also unaware about the contents of the respective syringe with which he performed PS infiltration for each patient. The non-scrub assistant and anaesthetist coordinated among each other for the smooth functioning of the study. The tourniquet monitor was under the supervision of the anaesthetist and alarms were muted to preserve the unrevealed status of the patient. The standard anteromedial and anterolateral portals were established with an 11 no. Blade along with a superolateral drainage portal (using a small trochar) arthroscopy was carried out by the senior surgeon.

Intraoperative details were recorded on a data collection form filled by the surgeon at the end of the procedure (Fig. 1 – data collection form). Intraoperative visibility was scored from 1 (worst: > 13 flushes needed) to 5 (best: 0 flushes) based on the number of flushes with saline required during surgery (Fig. 1 – data collection form). In case the intraoperative visibility was poor and/or necessitated the inflation of tourniquet, the surgeon still remained blinded to whether the patient belonged to group A or C. Other information gathered included the surgeon satisfaction recorded on a scale form 0 (best: most satisfied) to 10 (worst: extremely difficult to proceed) on the S-VAS score, amount of fluid required, duration of surgery and intraoperative MAP and HR (Fig. 1 – data collection form).

After the completion of the procedure, tourniquet deflation was also performed after the surgeons exit (group B). An identical, standardised postoperative protocol was followed for all patients with recovery room antiinflammatory injections of 75 mg diclofenac on twice daily basis for first 24 h. Additional requirements during hospital, if any, of intravenous tramadol or paracetamol were noted. Weight bearing was started on the first postoperative day (POD). Wound inspection and change of dressings were done on POD-2 while removal of stitches was performed on POD-12. Forms of all patients were comprehensively completed and data was evaluated using the Statistical Package for the Social Sciences Version 21.0 (SPSS Inc., IBM Corp., New York, USA).

3. Results

The group-wise demographic details of patients were comparable and can be observed from Table 1. The data collection forms of all patients were analysed and computed (Table 2).

Intraoperative visibility scores between the 3 groups had statistically significant differences between them ($p = 0.003$). Inter-group analysis revealed that significantly better visualization was reported in both groups B and C when compared with group A ($p = 0.003$, $p = 0.027$ respectively). The differences in mean scores between groups B and C, however, were not significant ($p = 0.705$) (Figs. 2 and 3).

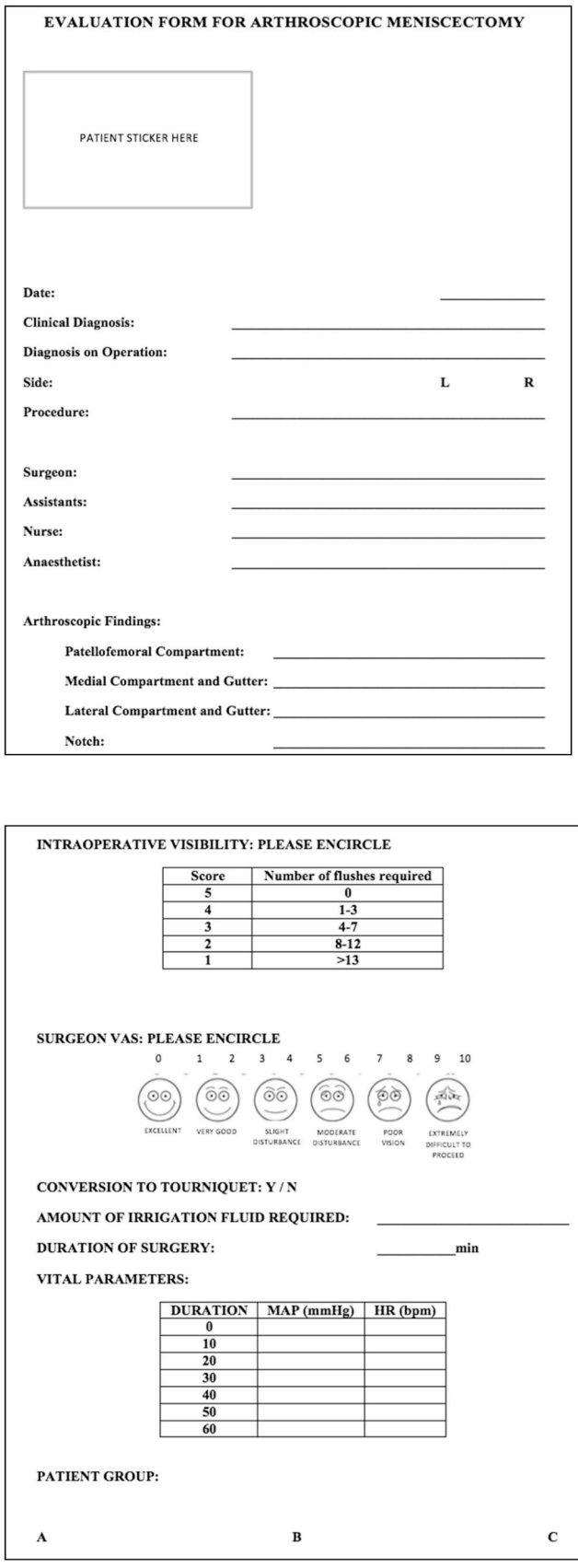
Similar results were obtained on analysis of the S-VAS scores between three groups where an overall significant difference existed between groups A, B, and C. Inter-group analysis, however, revealed comparable scores between groups B and C ($p = 0.805$). Poor visibility intraoperatively necessitated conversion to tourniquet in 2 patients both of whom belonged to group A (Figs. 4 and 5).

Progressively increasing surgical times and amount of irrigation fluid in groups B through A were noted. Although the differences in the amount of fluid consumed were statistically significant between all three groups, the operating times between groups B and C were comparable ($p = 0.05$) (Table 2).

The mean intraoperative MAPs taken at 10-min intervals, for groups A, B, and C ranged from 42 to 112, 53–172, 57–112 mmHg respectively. Mean HR recorded at similar intervals for the three groups had the following respective values: 59–103, 55–120, and 45–92 beats per minute (bpm). Both parameters did not vary significantly between groups A, B, and C when analysed collectively as well between each group (Table 2). The requirements of painkillers among the three groups were, also, not significantly different.

4. Discussion

The findings of this study illustrated comparable intraoperative visibility in patients belonging to groups B (tourniquet with PS local anaesthetic) and C (PS with PILE), in terms of the requirement of flushes intraoperatively and surgeon-VAS scores have helped validate a safe alternate to tourniquet inflation in patients undergoing knee arthroscopy. Poor visibility necessitated conversion to tourniquet in 2 patients belonging to the control group without significantly affecting the surgical time. The hypothesis, that PS injections would be capable of



EVALUATION FORM FOR ARTHROSCOPIC MENISCECTOMY

PATIENT STICKER HERE

Date: _____

Clinical Diagnosis: _____

Diagnosis on Operation: _____

Side: L R

Procedure: _____

Surgeon: _____

Assistants: _____

Nurse: _____

Anaesthetist: _____

Arthroscopic Findings:

Patellofemoral Compartment: _____

Medial Compartment and Gutter: _____

Lateral Compartment and Gutter: _____

Notch: _____

INTRAOPERATIVE VISIBILITY: PLEASE ENCIRCLE

Score	Number of flushes required
5	0
4	1-3
3	4-7
2	8-12
1	>13

SURGEON VAS: PLEASE ENCIRCLE

0 1 2 3 4 5 6 7 8 9 10

EXCELLENT VERY GOOD SLIGHT DISTURBANCE MODERATE DISTURBANCE POOR VISION EXTREMELY DIFFICULT TO PROCEED

CONVERSION TO TOURNIQUET: Y / N

AMOUNT OF IRRIGATION FLUID REQUIRED: _____

DURATION OF SURGERY: _____min

VITAL PARAMETERS:

DURATION	MAP (mmHg)	HR (bpm)
0		
10		
20		
30		
40		
50		
60		

PATIENT GROUP:

A B C

Fig. 1. Data collection form (pages 1 and 2).

Table 1
Demographic data.

Parameter	Group A	Group B	Group C	p value
N	20	20	20	–
M, F	11, 9	12, 8	11, 9	0.934
Mean ages (yrs.)	34	32	38	0.414

N: number of patients, M: Male, F: Female.

matching visualization offered by the tourniquet, was backed by results from the present study and proved accurate and verifiable.

Despite benefits in terms of better visualization, documented complications with tourniquet use have been extensively elaborated in literature. In a comprehensive review on neurovascular complications of arthroscopic knee surgery by Kim et al. important and potentially limb and life-threatening tourniquet-associated issues were identified as nerve compressions, arterial occlusions, haemarthrosis, delayed muscle recovery and prolonged rehabilitation, compartment syndrome and thromboembolism.[18] The risk of these complications has been shown to have a direct correlation with the tourniquet-time.[19] While in certain randomised and controlled studies, tourniquet-enabled visualization has emerged up to 3 times superior in comparison with controls, others have labelled it "unnecessary" in view of its inability to provide superior visuals and the disadvantage of significant postoperative pain.[7,8,12] In the present study, the omission of the tourniquet from the surgical protocol did not lead to any adverse effect on the surgical visualization. While the analgesic requirements did not significantly vary among the three groups, the additional benefit of a tourniquet for arthroscopy could not be established.

The mean surgical times were longer in group A (controls) versus groups B and C, and comparable between groups B and C evincing a parallel efficacy of epinephrine-laden local anaesthetics with the tourniquet without adverse implications on the duration of procedures. Group A also ranked first in the amount of fluid utilised for arthroscopy followed respectively by groups C and B. Notwithstanding these contretemps, the clinical impact of a higher mean fluid consumption in group C versus B (210 ml) was a dubious conjecture more so since the surgical times were similar.

Among others, the primary indication to use a tourniquet in surgery is to achieve a bloodless field, which in turn can enable a smoother and quicker performance by the surgeon. This widely held notion has, however, been recently challenged and even disproved in a recent meta-analysis by Zhang and colleagues in 2013. The authors evaluated 471 participants from 5 randomised controlled trials and concluded that visualization and operating times did not significantly vary with or without the tourniquet ($p = 0.15$, 0.19 respectively).[20] However, the authors did concede that there was significant heterogeneity of data between the studies, which would possibly restrict a broader implementation of their results. Also, they did not establish an alternative, safer method for arthroscopic visualization such as PILE. Coequal visualization with tourniquet and PILE without a prolongation of the surgical duration, after a randomised comparison with controls in the present study, establishes lignocaine-epinephrine portal injections as risk-free and dependable options for clear arthroscopic fields.

A randomised controlled trial by Kirkley et al. not included in the above-mentioned meta-analysis, reported that a three-fold improvement in visualization with a tourniquet, the mean operative times did not differ statistically. Moreover, a significant increase in pain was reported in the tourniquet group where operative times exceeded 30 min ($p = 0.019$).[8] The above study, again, didn't provide a solution of simultaneously achieving clear visibility, and a painless postoperative course. In contrast to their findings, Group B patients in our study did not experience additional pain on comparison with the other groups. A possible explanation for this could be a relatively short mean length of surgery of 19.25 min (overall, across all categories - 22.4 min). Another diverging analogy with the Kirkley et al. paper was the commensurable

Table 2
Comparative analysis of intraoperative variables.

Parameter			Group A		Group B		Group C	p value (95%CI)
Intraoperative visibility score (mean)			3.05	3.70		3.55		**0.003 (3.27–3.60)**
A	**B**	**p = 0.003**						
		95%CI (-1.1 - -0.2)						
A	**C**	**p = 0.027**						
		95%CI (-0.95 - -0.05)						
B	C	p = 0.705						
Surgeon VAS (mean)			2.90		1.05		1.35	**0.002 (1.3–2.24)**
A	**B**	**0.010**						
		95%CI (0.39–3.31)						
A	**C**	**0.042**						
		95%CI (0.04–3.06)						
B	**C**	**0.805**						
		95%CI (-1.22–0.62)						
Conversion to tourniquet (no. Of patients)			2		–		0	0.126
Amount of fluid required (ml)			2530		1895		2105	0.001
A	**B**	**p < 0.001**						
A	**C**	**p < 0.001**						
B	**C**	**p = 0.024**						
Duration of surgery (minutes)			26.25		19.25		20.75	0.001
A	**B**	**p < 0.001**						
A	**C**	**p < 0.001**						
B	**C**	p = 0.05						
Mean MAP (mm Hg)		**0 min**	71.60		79.95		76.43	0.242
(Overall range 42–172)		**10 min**	76.85		80.00		81.35	0.475
		20 min	79.16		82.47		79.41	0.616
		30 min	77.00		88.67		78.40	0.342
Mean HR (bpm)		**0 min**	75.10		74.25		74.98	0.909
(Overall range 42–172)		**10 min**	78.25		73.65		74.65	0.399
		20 min	74.74		74.94		73.94	0.967
		30 min	72.75		82.17		77.60	0.302

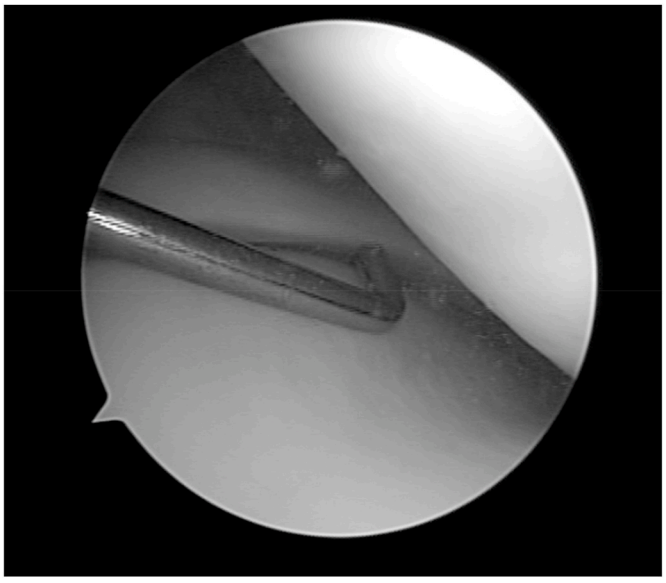


Fig. 2. Clear intraoperative visualization in a group B patient.

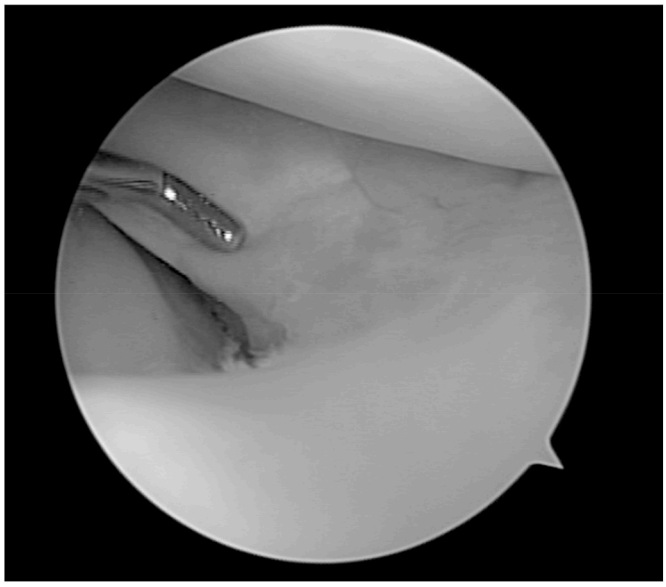


Fig. 3. Clear intraoperative visualization in a group C patient.

intraoperative visibility in both B and C groups in our research perhaps resulting from PILE in group C, a category that the former did not include in their paper.

Some investigators, seeking a safer and equally efficient method, have explored other options including injecting PS with local anaesthetics and epinephrine.[15,17,21,22] Our study was among a few, if not the only one, to have compared safety and efficacy of PS injections vis-a-vis the tourniquet, and also juxtaposed the findings over a control population. The dilution with of epinephrine has ranged from 1:100,000 to 1:200,000, based on published work. Most of these studies have performed PS (ranging from 10 to 25 ml of 1% lignocaine with epinephrine in 1:200,000 dilution) along with intraarticular infiltration (25–50 ml of 0.25% bupivacaine and 1% lignocaine with 1:200,000 epinephrine) into the knee joint.[15,21,22] Only a paper by Karaoglu has looked at the role of adding epinephrine to local PS injections in arthroscopic surgery. However, their prospective, randomised study did not compare the visualization with tourniquet, which is by far, the most frequently employed technique to achieve clear intraoperative visibility.[17] As observed by these authors, there were instances intraoperatively where alterations in vital parameters were reported in patients receiving intraarticular and PS epinephrine. The 5-min HR was significantly higher with intraarticular and PS epinephrine (250 μg) while the MAP was higher at 5 min in patients receiving PS epinephrine (50 μg)

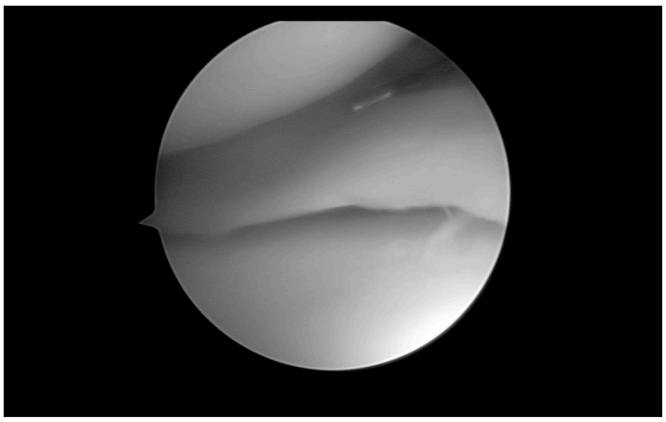


Fig. 4. Hazy intraoperative visualization in a group a patient which required tourniquet inflation.

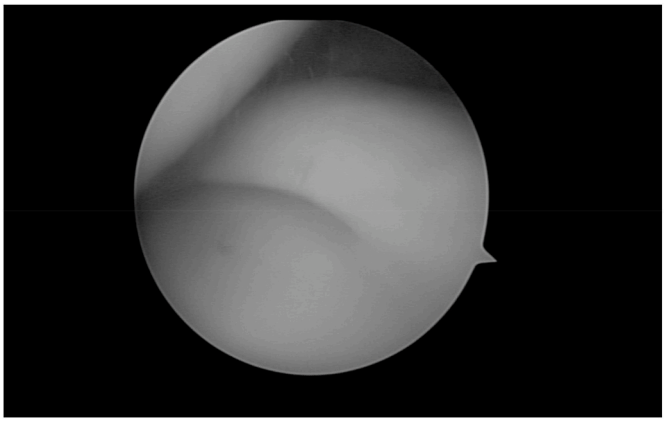


Fig. 5. Poor intraoperative visualization in a group a patient which required tourniquet inflation.

(strengths not mentioned).[17] In addition to tachycardia, arrhythmias, tremors and hypertension, local anaesthetic systemic toxicity (LAST) and adrenaline-associated pulmonary edema, have also described in recent literature.[17,23] This has reportedly caused near-fatal cardiac arrest in a 73 year-old Japanese patient receiving intraarticular levobupivacaine after knee arthroplasty.[23] By avoiding the intraarticular injections of anaesthetic agents, one may circumvent the local and systemic toxicity of these potentially life-threatening agents, which was the rationale for abandoning the same in the present study. All patients were stable throughout their respective surgeries and no significant changes were seen across all three groups w.r.t. Vital parameters.

It could be concurred from our findings that portal-site injections with 2% lignocaine and epinephrine in 1:200,000 is beneficial and innocuous in controlling bleeding and enhancing visibility in arthroscopic surgery. The solution is readily available commercially and can be used safely without the additional risks of having to dilute the drug, errors associated with which have been reported to touch almost 30% in surgical environs.

A few have theorised and illustrated in in-vitro studies that epinephrine combined with local anaesthetics can have potentially detrimental effects on cartilage health.[16] Although pH has been seen as being more inimical to chondrocyte viability than local anesthetics per se, in the present study, small doses of only local PS injections, not directed into the joint, were employed. This would have eliminated potential adverse effects, if any, of lignocaine and epinephrine on the articular cartilage.

This study has its limitations in having a relatively small sample size however; it is the first-of-its-kind, and has been conducted in a randomised, controlled, and blinded manner to provide a high quality of evidence. Data on long-term follow-up was also not available for the present study. We also appreciate the drawbacks of having a single surgeon subjectively rate visualization and satisfaction and the associated variables which have not been accounted in this study. However, by having a single surgeon in this research, there was a certain degree of standardization in preoperative, procedural and postoperative routines.

5. Conclusion

In conclusion, our findings support portal-site injections as low-risk and efficacious surrogates to the tourniquet in arthroscopic meniscectomy. This simple, safe, potent and relatively under-recognised modality has a convincing role to play in controlling bleeding and improving visualization in arthroscopic knee surgeries.

Declaration of competing interest

None.

References

1 Noordin S, McEwen JA, Kragh Jr JF, et al. Surgical tourniquets in orthopaedics. *J Bone Joint Surg Am*. 2009;91:2958–2967.
2 Johnson DS, Hirst P, Harper NJN. Practices of surgeons in Britain concerning tourniquet use in arthroscopy of the knee. *Arthroscopy*. 1998;14:230–231.
3 Murphy CG, Winter DC, Bouchier-Hayes DJ. Tourniquet injuries: pathogenesis and modalities for attenuation. *Acta Orthop Belg*. 2005;71:635–645.
4 Tsarouhas A, Hantes ME, Tsougias G, Dailiana Z, Malizos KN. Tourniquet use does not affect rehabilitation, return to activities, and muscle damage after arthroscopic meniscectomy: a prospective randomised clinical study. *Arthroscopy*. 2012;28:1812–1818.
5 Hoogeslag RA, Brouwer RW, van Raay JJ. The value of tourniquet use for visibility during arthroscopy of the knee: a double-blind, randomised controlled trial. *Arthroscopy*. 2010;26:S67–S72.
6 Jarrett PM, Ritchie IK, Albadran L, et al. Do thigh tourniquets contribute to the formation of intra-operative venous emboli? *Acta Orthop Belg*. 2004;70:253–259.
7 Johnson DS, Stewart H, Hirst P, Harper NJ. Is tourniquet use necessary for knee arthroscopy? *Arthroscopy*. 2000;16:648–651.
8 Kirkley A, Rampersaud R, Griffin S, et al. Tourniquet versus no tourniquet use in routine knee arthroscopy: a prospective, double-blind, randomised clinical trial. *Arthroscopy*. 2000;16:121–126.
9 Maletis GB, Inacio MC, Reynolds S, Funahashi TT. Incidence of symptomatic venous thromboembolism after elective knee arthroscopy. *J Bone Joint Surg Am*. 2012;94:714–720.
10 Smith TO, Hing CB. A meta-analysis of tourniquet assisted arthroscopic knee surgery. *Knee*. 2009;16:317–321.
11 Tibrewal SB. The pneumatic tourniquet in arthroscopic surgery of the knee. *Int Orthop*. 2001;24:347–349.
12 Thorlund JB, Hare KB, Lohmander LS. Large increase in arthroscopic meniscus surgery in the middle-aged and older population in Denmark from 2000 to 2011. *Acta Orthop*. 2014;85:287–292.
13 Furia JP, Zambetti Jr GJ. An injection technique to create a bloodless field in arthroscopically assisted anterior cruciate ligament reconstruction. *Am J Sports Med*. 1992;20:406–409.
14 Olszewski AD, Jones R, Farrell R, Kaylor K. The effects of dilute epinephrine saline irrigation on the need for tourniquet use in routine arthroscopic knee surgery. *Am J Sports Med*. 1999;27:354–356.
15 Weiker GG, Kuivila TE, Pippinger CE. Serum lidocaine and bupivacaine levels in local technique knee arthroscopy. *Am J Sports Med*. 1991;19:499–502.
16 Dragoo JL, Korotkova T, Kim HJ, Jagadish A. Chondrotoxicity of low pH, epinephrine, and preservatives found in local anaesthetics containing epinephrine. *Am J Sports Med*. 2010;38:1154–1159.
17 Karaoglu S, Dogru K, Kabak S, Inan M, Halici M. Effects of epinephrine in local anaesthetic mixtures on hemodynamics and view quality during knee arthroscopy. *Knee Surg Sports Traumatol Arthrosc*. 2002;10:226–228.
18 Kim TK, Savino RM, McFarland EG, Cosgarea AJ. Neurovascular complications of knee arthroscopy. *Am J Sports Med*. 2002;30:619–629.
19 Sherman OH, Fox JM, Snyder SJ, et al. Review. Arthroscopy-"no-problem surgery". An analysis of complications in two thousand six hundred and forty cases. *J Bone Joint Surg Am*. 1986;68:256–265.
20 Zhang Y, Li L, Wang J, Li ZH, Shi ZJ. Do patients benefit from tourniquet in arthroscopic surgeries of the knee? *Knee Surg Sports Traumatol Arthrosc*. 2013;21:1125–1130.

21 Martin RC, Brown DE, Zell BK, Lichtman DM. Diagnostic and operative arthroscopy of the knee under local anaesthesia with parenteral medication. *Am J Sports Med*. 1989;17:436–439.
22 Shapiro MS, Safran MR, Crockett H, Finerman GA. Local anaesthesia for knee arthroscopy. Efficacy and cost benefits. *Am J Sports Med*. 1995;23:50–53.
23 Tomita A, Satani M, Suzuki K, Kaji A, Urushitani S. A case of cardiac arrest following intra-articular administration of levobupivacaine during total knee arthroplasty. *Masui*. 2016;65:179–183.