Application of ox muzzle drainage in knee arthroscopy

daifeng Lu (✉ ludaifengletter@163.com)

The Fourth Affiliated Hospital of Harbin Medical University <https://orcid.org/0000-0002-7533-9549>

Jingbo Li

Harbin Medical University

Zhitao Zhang

Harbin Medical University

Mochao Xiao

Harbin Medical University

Research article

Keywords: ox muzzle drainage, arthroscopy, irrigation, pump

Posted Date: January 17th, 2020

DOI: <https://doi.org/10.21203/rs.2.21143/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

Background: Ox muzzle drainage is a type of drainage system surrounding the anterior internal and lateral incision of knee arthroscopy. This study investigated the role of ox muzzle drainage in keeping the surgical field clear and decreasing the operative time in knee arthroscopy.

Methods: A total of 63 patients with meniscal associated injury who underwent knee arthroscopic meniscus partial resection between May 2011 and June 2014 were retrospectively analyzed. Ox muzzle drainage was applied in 31 patients, while the other 32 patients were served as conventional drainage group. The volume of irrigation fluid drained from the knee articular cavity, duration of operation, operative view clarity and complications were compared. Visual clarity was rated by a Numeric Rating Scale.

Results: The irrigation fluid volume was significantly greater, while duration of operation was markedly shorter in the ox muzzle drainage group than the control ($P < 0.05$). The operative view clarity in the ox muzzle drainage group was obviously better than the control ($P < 0.05$). One patient in the ox muzzle drainage group developed articular effusion of the knee joint after the operation, which improved markedly after paracentesis and betamethasone articular injection at 3 months after operation. Two patients in the control group experienced reddening at the incision, leading to delayed wound healing. No statistical difference was observed in the number of complications after operation between the two groups ($P > 0.05$).

Conclusions: Ox muzzle drainage is feasible for intra-operative irrigation and stretching of the fat pad in knee arthroscopy, offering the advantage of a shorter operation time and, thus, potentially improved safety.

Introduction

In recent years, with continued improvements in living standards, fitness consciousness has greatly increased, leading to greater numbers of sports-related injuries. Due to its usefulness for accurate diagnoses and minimally invasive treatments, arthroscopy has brought about revolutionary progress in the repair and reconstruction of bone and joint injuries and, thus, has become the routine surgery in the repair of the knee joint. However, the minimally invasive nature of this procedure requires great technical skill. Drainage of the irrigation solution is usually inadequate due to shielding by the capsula articularis and related soft tissue. Moreover, the operation equipment is difficult to fit in the joint cavity, and bulging of the fat pad into the knee joint cavity makes imaging unclear, resulting in extended operative times and difficulty in repairing lesions, which is especially troubling for inexperienced surgeons.

Intra-articular bleeding has been proposed as the main cause of effusion after knee arthroscopy.^[1, 2] The hematoma that forms after deflation of the tourniquet postoperatively may attach to the surgically incised or excised surfaces.^[3] During arthroscopy, the synovium and fat pad may need to be partially removed to visualize the anterior part of the menisci.^[4, 5] The bleeding that occurs after partial removal of

the synovium leads to knee effusion and compromises rehabilitation.^[4] Drainage is widely used in orthopedic interventions and will, theoretically, remove the initial hemarthrosis.^[3] Some studies have reported that drains prevent effusions and painful irritation of the knee by reducing synovial irritation,^[1, 2] whereas some authors have reported no perceived benefit of drainage.^[6–11] The benefits of drainage following arthroscopic knee surgery have been specifically studied in anterior cruciate ligament reconstruction or combined procedures, such as chondral drilling, partial or subtotal meniscectomy, synovial shaving, and chondral debridement.^[12]

Despite the perceived advantages of drainage, further improvements to common are needed to overcome limitations related to the irrigation amount, view, and equipment convenience. Ox muzzle drainage was first applied in drainage of the focus of infection in osteomyelitis, and a good curative effect was obtained.^[13] Ox muzzle drainage is a type of drainage system surrounding the anterior internal and lateral incision of knee arthroscopy. It is only used in the operation to promote the discharge of intra-articular fluid, and is removed after surgery. Therefore, this study investigated the benefits of application of ox muzzle drainage in arthroscopic surgery, specifically with respect to the lavage amount, the ability to position surgical instruments in the joint cavity, and the ability to pull open the fat pad.^[14]

Materials And Methods

Patient information

A total of 63 patients with a third-degree meniscus combined injury who underwent knee arthroscopic meniscus partial resection between May 2011 and June 2014 were retrospectively analyzed. Subjects with contraindications for knee arthroscopy were excluded. The test group consisted of 31 patients in whom ox muzzle drainage was applied, and the control group consisted of 32 patients who underwent knee arthroscopy without ox muzzle drainage as routine drainage group. This study was approved by the ethics committee of the Fourth Affiliated Hospital of Harbin Medical University, and all enrolled patients provided written informed consent.

Operative method

For the patients in the ox muzzle drainage group, the infusion apparatus tube was cut to 20 cm in length. The knee joint was flexed at 90°, and a conventional lateral longitudinal incision of 1 cm in length was made. The large drainage tube was put into the knee articular cavity through the inner incision and inclined by about 45°, and the holding forceps were placed in the cavity from the lateral incision in closed status. Next, the drainage tube was held by the forceps and moved to the inner incision, causing the head of the forceps to extend out of the inner incision. Then the infusion tube was reflexed at 10 cm, held by the forceps, and pulled from the lateral incision. A plier was used to extend the exterior and interior incisal opening of the articular capsule and for arthroscopy entry from the exterior side. Finally, the inner infusion tube was fit into the reflection end and placed under tension for the arthroscopic operation (Figs. 1A-D). For the patients in the control group, routine arthroscopy was performed. The volume of irrigation fluid

drained from the knee articular cavity, the duration of operation, operative view clarity, The primary goal was to measure visibility during the arthroscopic procedure. Visual clarity was scored by the surgeon by using the Numeric Rating Scale (NRS 0 to 10, with 10 corresponding to the best visual clarity possible) every 5 to 10 minutes and at all times of increasing fluid pressure, An NRS of < 4 was defined as “poor,” “fair” when $4 < \text{NRS} < 7$, and “good” when $\text{NRS} > 7$. The cut off value for NRS was set at > 7 because this is defined as a good intraoperative visibility^[15], and complications were compared between the two groups. All the operations were performed by one surgeon using the same arthroscopy system (STORZ, Germany) and gravity perfusion system without tourniquet.

Statistical analysis

SAS9.3 software was used for data analysis. Measurement data are shown as mean $\pm$ standard deviation, and significant differences were identified by t test or rank sum test. Enumerated data were compared by chi-square test. $P < 0.05$ was considered indicative of statistical significance.

Results

Overall, 31 patients underwent knee arthroscopy with ox muzzle drainage, including 15 men and 16 women with a mean age of 37.58 ± 10.67 years (range, 22–60 years). Among these cases, 13 involved left knees and 17 involved right knees, and 1 suffered required double knee arthroscopy. Another 32 patients who underwent knee arthroscopy without ox muzzle drainage were selected as controls, including 15 men and 17 women with an average age of 35.94 ± 9.99 years (range, 19–59 years). The cases in the control group included operations on 10 left knees and 20 right knees, and two cases of double knee arthroscopy.

As shown in Table 1, age, gender, and side did not differ significantly between the two groups ($P > 0.05$). The mean irrigation volume in the ox muzzle drainage group was (median, 4000 ml [range, 3000–6000 ml]), which was significantly greater than that in the control group (median, 2850 ml [2000–5000 ml]; $P = 0.0058$). Compared with the control operation, ox muzzle drainage provided an obviously clearer intraoperative view (Figure 2). The median operation time in the ox muzzle drainage group was only 32 min, which was significantly shorter than that in the control group (41.5 min, $P = 0.0467$, Table 2).

The visual clarity is expressed as a percentage of “good visibility” ($\text{NRS} > 7$) due to correction of variable operating duration. Therefore, the visual clarity is presented as a number between 0% and 100%. There was a significant main effect of the intervention measured on clarity of view, which showed that in the Ox muzzle drainage group a greater percentage of clarity of the view was seen than in the control group ($t = -5.474$, $P = 0.009$, Table 3).

The numbers of post-operative complications did not differ between the two groups ($P > 0.05$). Specifically, one patient in the ox muzzle drainage group developed articular effusion in the knee joint after the operation. The patient’s symptoms improved markedly after paracentesis and betamethasone articular

injection at 3 months after the operation. Two patients in the control group presented with incision reddening, leading to delayed wound healing.

Discussion

We aimed to determine whether ox muzzle drainage in knee arthroscopy offers a significant benefit in surgical time, irrigation volume, and complications compared to the normal procedure. The results of this study indicate that ox muzzle drainage with double traction does reduce the operative time and increase the amount of irrigation possible, while not changing the rate of operative complications. This is likely due to the improved visualization and better drainage provided by the ox muzzle. To our knowledge, this is the first report about the application of ox muzzle drainage in knee arthroscopy.

Arthroscopy was improved from the cystoscopic method, which was first used by Kenji Takagi for knee joint inspection in 1919. He invented the first 7.3-mm endoscope in 1920 for joint inspection and named it the arthroscope. Later in 1931, it was redesigned at only 3.5 mm, and this instrument would be the prototype for modern optical arthroscopy equipment.^[16] Bircher adopted Jacobeus laparoscopy for knee joint examination in 1921 and applied oxygen or nitrogen gas to expand the joint. Yanmis^[17] and Kuo^[18] reported that application of arthroscopy and an irrigation system in the treatment of purulent knee arthritis obtained a better knee joint function recovery effect than the extensive surgical operation. Thorough irrigation for joint capsule expansion and a guarantee of clear vision are necessary for the operation. Irrigation can remove the bleeding and debris, which is helpful for observing the interior joint cavity more clearly. At present, there are two methods for knee joint cavity irrigation: suspensory gravity irrigation and perfusion pressure pump irrigation. Suspensory gravity irrigation is a classic surgical method with advantages of lower equipment costs and simpler technology. However, the disadvantage is that the perfusion pressure is unstable. Low pressure can cause vision to be blurred by joint cavity hemorrhage, whereas high pressure can cause turbulence, which is bad for vision and increases the degree of edema after the operation. The perfusion pressure pump method offers the advantage of an adjustable pressure, which helps maintain clear vision and reduces the operative time.^[5] It can alleviate the degree of edema after operation by reducing the infiltration of liquid. Moreover, it can prevent the phenomenon of water interruption and air entering the joint cavity. However, the related equipment is associated with certain costs. On the other hand, the pressure difference of less than 50 mmHg compared with the systolic pressure can reduce bleeding and improve the clarity of vision, although it also may increase the risk of perfusion fluid extravasation and lead to osteofascial compartment syndrome. Seig thought that the perfusion pump could shorten the operation time compared with suspensory irrigation.^[19] Contrarily, Tatari proposed that although use of drains can improve the vision, they are unnecessary for partial meniscectomy, cartilage repair, or limited synovial plica excision operations.^[20] In addition, drains cannot keep the pressure stable in the knee joint.^[21] Suspensory irrigation cannot provide clear vision, because the drainage may be blocked by the subcutaneous tissue and joint capsule under the lateral edge of the incision. Thus, a drain tube is needed to discharge the irrigation fluid containing blood and debris, which further extends the operation time.^[22]

Ox muzzle drainage permits sufficient drainage in multiple conditions such as osteomyelitis. Therefore, we applied ox muzzle drainage in knee arthroscopy by placing the drain through the exterior and interior incision. Ox muzzle drainage was associated with three advantages. First, it holds the subcutaneous tissue under the edge and prevents aggregation of the knee joint capsule cannot, which benefits clear vision. Secondly, the ox muzzle drainage tube can effectively pull open the fat pad to improve the surgical view, instead of cleaning the fat pad, thus shortening the operation time. Thirdly, the surgical instruments can be placed within the joint cavity to place the tube easily, avoiding unnecessary side injury to structures such as the articular cartilage, meniscus, and cruciate ligament.^[23–26] Lastly, it may avoid osteofascial compartment syndrome caused by fluid infiltration to the crural fascia upon osmotic pressure.^[25] Therefore, ox muzzle drainage is theoretically an ideal choice for knee arthroscopy.

We attempted to provide a better overall rating of the visualization by having the surgeon score the quality of the visibility (NRS) every 5 to 10 minutes. In accordance with the method used by Tuijthof et al. the visual clarity is measured and expressed as a percentage of “good visibility” (NRS > 7). We found a 21% improved visual clarity in the ox muzzle drainage group. Turbidity is the most common source of disturbance in knee arthroscopy and is present during a considerable percentage of the operation time. Our results show that for routinely performed arthroscopic knee operations, the ox muzzle drainage system resulted in a significantly reduced presence of turbidity. This finding can be explained by the continuous flow that spanned a wider area due to the traction of the drainage tube, as opposed to the flow caused by leakage along the portals. Meanwhile, the larger amount of irrigation used in ox muzzle drainage group further supports this conclusion. In addition, the shorter operation time in the ox muzzle drainage group also prompted faster and easier insertion and removal of the surgical instruments. No difference was observed in the numbers of complications in the two groups, suggesting that ox muzzle drainage led to no more complications than the traditional method.

Our study had some limitations. Our series was not large, because this is a new attempt in knee arthroscopy. Moreover, our follow-up time was short, which means some complications may not have been detected. Thus, a study with a larger population and longer follow-up is needed to better evaluate the effectiveness and convenience of ox muzzle drainage in knee arthroscopy. Furthermore, many experienced surgeons can still create a clear surgical view and shorten the operation time effectively without ox muzzle drainage. Therefore, in our opinion, ox muzzle drainage is most helpful for beginner surgeons performing knee arthroscopy.

Conclusion

Our investigation demonstrated that use of ox muzzle drainage in knee arthroscopy resulted in a clearer surgical view and similar numbers of operative complications compared with the traditional method not involving ox muzzle drainage. Thus, we believe that ox muzzle drainage is a feasible method for the drainage of intra-operative irrigation fluid and stretching of the fat pad in knee arthroscopy, and that this approach can effectively improve the field of vision and shorten the operation time for knee arthroscopy, especially for beginner surgeons.

Declarations

Ethics approval and consent to participate

This study was approved by the ethics committee of the Fourth Affiliated Hospital of Harbin Medical University, and all enrolled patients provided written informed consent.

Consent for publication

Written informed consent for publication was obtained from all participants

Availability of data and materials

All data are true and valid.

Conflict of Interest

The authors declare that they have no conflict of interest.

Funding Statement

This work was supported by the Harbin Science and Technology Innovation Special Funds for Youth Talents (No. 2017RAQXJ213), Heilongjiang Provincial Scientific Research Plan Project (No. 201807) and Plan Project of Fourth Affiliated Hospital of Harbin Medical University (No. HYDSYJQ201606).

Author contributions

DFL designed the study. JBL, ZTZ, MCX and DFL collected samples and analyzed the data. ZTZ and DFL drafted the manuscript and analyzed patient samples. MCX, ZTZ and DFL revised the manuscript critically for intellectual content. All authors gave intellectual input to the study and approved the final version of the manuscript.

Acknowledgments: None

Daifeng Lu, MD^{*}, Jingbo Li, MD, Zhitao Zhang, MD, Mochao Xiao, MD

Department of Orthopedics, Fourth Affiliated Hospital of Harbin Medical University, Harbin 150001, China

Heilongjiang Provincial Academy of Medical Sciences, Harbin 150086, China.

*Corresponding Author: Daifeng Lu

Department of Orthopedics, Fourth Affiliated Hospital of Harbin Medical University, No. 37 Yiyuan Road, Harbin 150001, China.

Heilongjiang Provincial Academy of Medical Sciences, No. 157 Baojian Road, Nangang District, Harbin 150086, China.

Tel.: +8615246776189; Email:ludaifengletter@163.com

References

1. Clifton R, Haleem S, McKee A, Parker MJ. Closed suction surgical wound drainage after anterior cruciate ligament reconstruction: a systematic review of randomised controlled trials. *Knee* 2007;14:348-51.
2. DeMaio M. Giants of orthopaedic surgery: Masaki Watanabe MD. *Clin Orthop Relat Res* 2013;471:2443-8.
3. Oh JH, Kim JY, Chung SW et al .Warmed irrigation fluid does not decrease perioperative hypothermia during arthroscopic shoulder surgery. *Arthroscopy* 2014 30(2):159–164
4. Johnson LL. Characteristics of the immediate postarthroscopic blood clot formation in the knee joint. *Arthroscopy* 1991;7:14-23.
5. Avery DM 3rd, Gibson BW, Carolan GF. Surgeon-rated visualization in shoulder arthroscopy: A randomized blinded controlled trial comparing irrigation fluid with and without epinephrine. *Arthroscopy* 2015;31:12-18.
6. Ashraf T, Darmanis S, Krikler SJ. Effectiveness of suction drainage after primary or revision total hip and total knee arthroplasty. *Orthopedics* 2001;24:1158-60.
7. Johnson LL. What I Have Seen and Learned Since Looking Through an Arthroscope: 43 Years and Counting. *Arthroscopy* 2015;31:1571-5.
8. Kim YH, Cho SH, Kim RS. Drainage versus nondrainage in simultaneous bilateral total hip arthroplasties. *J Arthroplasty* 1998;13:156-61.
9. Liang-Tseng Kuo, Chi-Lung Chen, Pei-An Yu, Wei-Hsiu Hsu, Ching-Chi Chi, Jae-Chul Yoo .Epinephrine in irrigation fluid for visual clarity in arthroscopic shoulder surgery: a systematic review and meta-analysis. *International Orthopaedics*;2018,6(22),424-428.
10. Widman J, Jacobsson H, Larsson SA, Isacson J. No effect of drains on the postoperative hematoma volume in hip replacement surgery: a randomized study using scintigraphy. *Acta Orthop Scand* 2002;73:625-9.
11. Vandit Sardana, Joanna Burzynski, Giles R. Scuderi. The influence of the irrigating solution on articular cartilage in arthroscopic surgery: A systematic review. *Journal of Orthopaedics* 2019; 16:158–165.
12. Milankov M, Savic D. The importance of irrigation suction drainage in the treatment of septic arthritis after anterior cruciate ligament reconstruction. *Arthroscopy* 2008;24:1434-5; author reply 5.
13. Green SA. Osteomyelitis. The Ilizarov perspective. *Orthop Clin North Am* 1991;22:515-21.

14. Tuijthof GJ, van den Boomen H, van Heerwaarden RJ, van Dijk CN. Comparison of two arthroscopic pump systems based on image quality. *Knee Surg Sports Traumatol Arthrosc* 2008;16:590-4.
15. Douwe O. van Montfoort, M.D., Paulien M. van Kampen, Ph.D., and Pol E. Huijsmans, M.D. Epinephrine Diluted SalineIrrigation Fluid in Arthroscopic Shoulder Surgery: A Significant Improvement of Clarity of Visual Field and Shortening of Total Operation Time. A Randomized Controlled Trial. *Arthroscopy: The Journal of Arthroscopic and Related Surgery* 2016;32(3):436-444.
16. Cheng D, Wang Y, Yu L, Liu X. Optical design and evaluation of a 4 mm cost-effective ultra-high-definition arthroscope. *Biomed Opt Express* 2014;5:2697-714.
17. Yanmis I, Ozkan H, Koca K, Kilincoglu V, Bek D, Tunay S. The relation between the arthroscopic findings and functional outcomes in patients with septic arthritis of the knee joint, treated with arthroscopic debridement and irrigation. *Acta Orthop Traumatol Turc* 2011;45:94-9.
18. Kuo CL, Chang JH, Wu CC, Shen PH, Wang CC, Lin LC, *et al.* Treatment of septic knee arthritis: comparison of arthroscopic debridement alone or combined with continuous closed irrigation-suction system. *J Trauma* 2011;71:454-9.
19. Sieg R, Bear R, Machen MS, Owens BD. Comparison of operative times between pressure and flow-control pump versus pressure-control pump for ACL reconstruction. *Orthopedics* 2009;32.
20. Tatari H, Dervisbey M, Muratli K, Ergor A. Report of experience in 190 patients with the use of closed suction drainage in arthroscopic knee procedures. *Knee Surg Sports Traumatol Arthrosc* 2005;13:458-62.
21. F. Stärke, F. Awiszus, C.H. Lohmann, C. Stärke . The effect of irrigation time and type of irrigation fluid on cartilage surface friction. *Journal of the Mechanical Behavior of Biomedical Materials*;2017,09008,124-129.
22. Gulihar A, Bryson DJ, Taylor GJ. Effect of different irrigation fluids on human articular cartilage: an in vitro study. *Arthroscopy* 2013;29:251-6.
23. Kocaoglu B, Martin J, Wolf B, Karahan M, Amendola A. The effect of irrigation solution at different temperatures on articular cartilage metabolism. *Arthroscopy* 2011;27:526-31.
24. Kosy JD, Schranz PJ, Toms AD, Eyres KS, Mandalia VI. The use of radiofrequency energy for arthroscopic chondroplasty in the knee. *Arthroscopy* 2011;27:695-703.
25. Amin AK, Huntley JS, Simpson AH, Hall AC. Increasing the osmolarity of joint irrigation solutions may avoid injury to cartilage: a pilot study. *Clin Orthop Relat Res* 2010;468:875-84.
26. Amin AK, Huntley JS, Patton JT, Brenkel IJ, Simpson AH, Hall AC. Hyperosmolarity protects chondrocytes from mechanical injury in human articular cartilage: an experimental report. *J Bone Joint Surg Br* 2011;93:277-84.

Tables

Table 1. General patient information

	Routine operation group	Ox muzzle drainage group	t/c ² /Z	P
Age (years)	35.949.99	37.5810.67	0.63	0.5303
Gender (male/female)	15/17	15/16	0.0144	0.9044
Side (right/left/bilateral)	10/20/2	13/17/1	1.3710	0.6287

Table 2. Operative time in the ox muzzle drainage group and control group

	Routine operation group	Ox muzzle drainage group	t/c ² /Z	P
Irrigation amount (ml)	2000–5000	3000–6000	2.7578	0.0058
Operation time (min)	20–60	15–50	-1.9892	0.0467
No. of cases with complications	2	1		1.0000

Table 3. Clarity of operative view in the ox muzzle drainage group and control group

	Routine operation group	Ox muzzle drainage group	t	P
Clarity of view	66.09%(40%-100%)	87.42%(60%-100%)	-5.474	0.009

NOTE. Clarity of view is expressed as a percentage of “good visibility” during the operation. Good visibility was defined as a Numeric Rating Scale >7.

Figures

Figure 1

Figure 1 was not included in this manuscript version.

Figure 2

Figure 2 was not included in this manuscript version.