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Additional periarticular catheter shows no superiority over single-shot local infiltration analgesia alone in unicondylar knee replacement

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Abstract

Purpose Local infiltration analgesia (LIA) has attracted growing interest in recent years. To prolong the positive effects of LIA, a continuous intraarticular perfusion has been introduced in total knee arthroplasty with good clinical results. The purpose of the present study was to evaluate if similar results can be obtained with the use of a continuous periarticular perfusion in unicondylar knee arthroplasty (UKA).

Methods 50 consecutively selected patients undergoing UKA received either a single-shot LIA (control group; $n=25$) or single-shot LIA combined with a continuous postoperative periarticular perfusion for 2 postoperative days (intervention group, $n=25$). VAS (visual analogue scale) for pain, pain medication consumption and range of flexion were recorded postoperatively for 6 days. The catheter was removed after 2 days.

Results Only minor advantages of using a continuous periarticular catheter could be shown. Patients in the intervention group showed significant lower VAS scores on day 1 and required significant less pain medication on day 6. Further, there was a significant difference in the range of flexion on day 3, on which patients of the intervention group were able to bend the knee joint on average by 12° more than patients of the control group. On the other days, any significant differences between the two groups were not observed.

Conclusion In summary, the present study could not identify any superiority of a periarticular catheter over single-shot LIA in UKA. Because of additional costs and the potential risk of infection, the conclusion of this study is to not recommend adding a periarticular catheter to the single-shot LIA in UKA.

Level of evidence II

Keywords UKA · Unicondylar knee arthroplasty · LIA · Local infiltration analgesia · Perioperative pain management · Total knee replacement

Abbreviations

UKA	Unicondylar knee arthroplasty
LIA	Local infiltration analgesia
VAS	Visual analogue scale
ROM	Range of motion
LMWHs	Low-molecular-weight heparins

Introduction

In unicondylar and total knee arthroplasty, postoperative pain is usually severe and may impede early recovery; intense postoperative pain reduces range of motion (ROM), increases analgesic consumption and prolongs hospital stay [9]. The objective of pain management should be a painless surgical experience while maintaining full mobility and sensibility to facilitate the patient's early recovery. Commonly used anaesthetic techniques show different side effects: nerve blocks impede the postoperative mobility and sensibility. Epidural analgesia can cause urinary retention and muscular weakness. High-dose opioid analgesia can cause

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sedation, nausea and vomiting, reduced gut motility and urinary retention and therefore this limits their application in daily clinical practice. Further, with regard to the United States facing an opioid epidemic [3, 12], the need for an effective non-opioid pain management becomes evident. Therefore, periarticular infiltration of local anaesthetics or so-called local infiltration analgesia (LIA) has attracted growing interest in recent years. Since the effect of single-shot LIA disappears within the first 24 h [1], the idea was to prolong this period with an additional intraarticular catheter.

In TKA, this procedure has been described as an effective treatment modality to reduce postoperative pain [8]. Unfortunately, a direct transfer of the positive results of the TKA study to UKA is not possible, since the catheter should be placed periarticularly due to the potential chondrotoxicity of the local anaesthesia on the remaining compartments.

The objective of the present study is to determine if the use of a periarticular catheter is superior to single-shot LIA only and therefore justifies the risks and costs associated with the use of a periarticular catheter.

The hypothesis of the present study is that the use of an additional periarticular catheter will lead to better pain control (lower VAS scores), less additional pain medication and better knee flexion.

Materials and methods

After informed consent was obtained, 50 consecutively selected patients suffering from medial osteoarthritis undergoing UKA were selected within a period of 4 consecutive months and assigned to one of two groups of pain management. Exclusion criteria were as follows: age under 18/over 85 years, neuropathy and polyneuropathy, paralysis, diabetes mellitus, non-compliance, cognitive or verbal restrictions or relevant allergies (to local anaesthetics or metal). Six patients were excluded because of insulin-dependent diabetes mellitus; no other patients met exclusion criteria.

Patients of the first group (control group, $n=25$) received per-operative single-shot LIA (200 ml ropivacaine at 2 mg/ml) only, which was applied before every incision and at the end of surgery into soft tissues and into the capsule. Patients of the second group (intervention group, $n=25$) received the same per-operative single-shot LIA and additionally a continuous periarticular catheter (Pajunk, Geisingen, Germany), delivering 200 ml ropivacaine (2 mg/ml) at a rate of 8 ml/h. The catheter was inserted from superolateral and placed on the suture of the capsule. To minimize the risk of infection, the insertion was done with the inside-out technique. Drape and catheter were not touched until removal.

Any significant differences preoperatively concerning VAS score, additional pain medication and flexion ability were not observed.

All surgeries were performed by the same surgeon (JB) through a medial parapatellar approach and all patients received the same implant (DePuy Synthes SIGMA® HP Partial Knee) and 1 g tranexamic acid i.v. In addition, all patients had the same intra- and postoperative setting: all patients underwent surgery under general anaesthesia with laryngeal mask. Any drains or tourniquet were not used. All patients received the same postoperative treatment. Full weight bearing with crutches as needed was allowed as well as flexion according to pain. Physiotherapy was started immediately and continued for several weeks if necessary. Low-molecular-weight heparins (LMWHs) were given for 2 weeks postoperatively.

For data acquisition, several clinical parameters were recorded for each patient preoperatively, then 6 h after surgery, and then every 24 h for 6 postoperative days. The parameters included pain, which was quantified by VAS (0–10), additional pain medication and function of the knee, i.e. flexion. VAS score and additional pain medication were collected by the same investigator (PB). Flexion ability was tested by the same physiotherapist three times using a goniometer and the highest value was recorded. The periarticular catheter was removed by the surgeon on postoperative days 3–5 (when empty).

This prospective cohort study was approved by the ethical committee of the local state medical council Baden Wuerttemberg (Approv. No. F-2017-025).

Statistical analysis

The a priori calculated sample size (Software G-Power 3.1—effect size 0.7, α-error 0.05, power 0.85) revealed a minimum of 21 subjects. Patient sample size was increased to 25 per group to eliminate unusable measurements or drop outs within the follow-up period. A Shapiro–Wilk test was performed to test the data for normal distribution. Statistical analysis was then carried out using the paired Student's t test for normally distributed data and the Mann–Whitney U test for not normally distributed data. The level of significance was defined as $\alpha=5\%$. Data for all parameters are presented with one decimal.

Results

In the present study there were no cases requiring revision surgery. Furthermore, there were no complications such as deep vein thrombosis, infections or haematomas.

The intervention group showed lower VAS scores compared to the control group for every day, however, with no significant difference, except for day 1.

Table 1 Information about the study cohort

	Mean age	Gender ratio female:male
Control group	63	13:12
Intervention group	62	12:13

The intervention group also needed less additional pain medication on every postoperative day, however, again with no significant difference, except for day 6.

There was a significant difference in the flexion ability on day 3, on which patients of the intervention group were able to flex the knee joint on average by 12° more than patients of the control group. All results are presented in detail in Tables 1, 2, 3, 4 and in Figs. 1, 2, 3.

Discussion

The most important finding of this study was that a periarticular catheter in addition with single-shot LIA did overall not show any clear superiority over single-shot LIA only. Therefore, the hypothesis of the present study has to be rejected. There were a few significant differences, for example less rebound pain occurred in the intervention group than in the control group, however, those small advantages may not justify the use of a catheter in UKA, due to the

Table 2 Average (SD) VAS score

	Pre-OP	OP-day	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Control group	4.0 (1.0)	1.8 (0.4)	2.8 (0.7)	2.5 (0.7)	2.2 (0.5)	2.5 (0.5)	2.3 (0.7)	2.1 (0.7)
Intervention group	3.6 (0.9)	1.7 (0.6)	2.4 (0.8)	2.3 (0.6)	2.1 (0.5)	2.3 (0.6)	2.1 (0.6)	2.0 (0.4)
p-value	0.071	0.18	0.02*	0.228	0.525	0.121	0.142	0.578

*Indicates $p < 0.05$

Table 3 Average (SD) of additional pain medication (morphine equivalents)

	Pre-OP	OP-day	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Control group	9.6 (6.9)	16.7 (4.2)	32.6 (6.4)	31.8 (9.6)	33.6 (9.6)	29.1 (2.0)	26.8 (7.3)	24.1 (8.2)
Intervention group	12.8 (4.8)	16.7 (7.0)	32.2 (10.7)	30.2 (11.8)	31.7 (11.2)	27.4 (7.0)	24.6 (7.6)	17.3 (7.1)
p-value	0.055	0.045	0.394	0.147	0.061	0.162	0.102	0.002*

*Indicates $p < 0.05$

Table 4 Average (SD) flexion ability in degree

	Pre-OP	OP-day	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Control group	117 (10)	81 (5)	59 (16)	64 (17)	71 (14)	79 (11)	85 (7)	87 (6)
Intervention group	119 (8)	80 (6)	60 (16)	72 (13)	83 (10)	84 (9)	86 (7)	88 (5)
p-value	0.791	0.55	0.8	0.06	0.001*	0.08	0.85	0.61

*Indicates $p < 0.05$

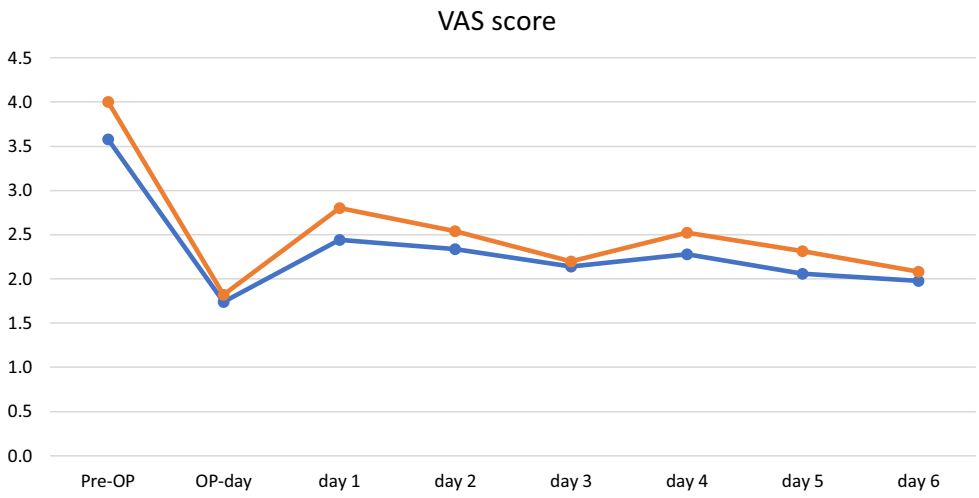

Fig. 1 VAS score: intervention group (blue); control group (orange)

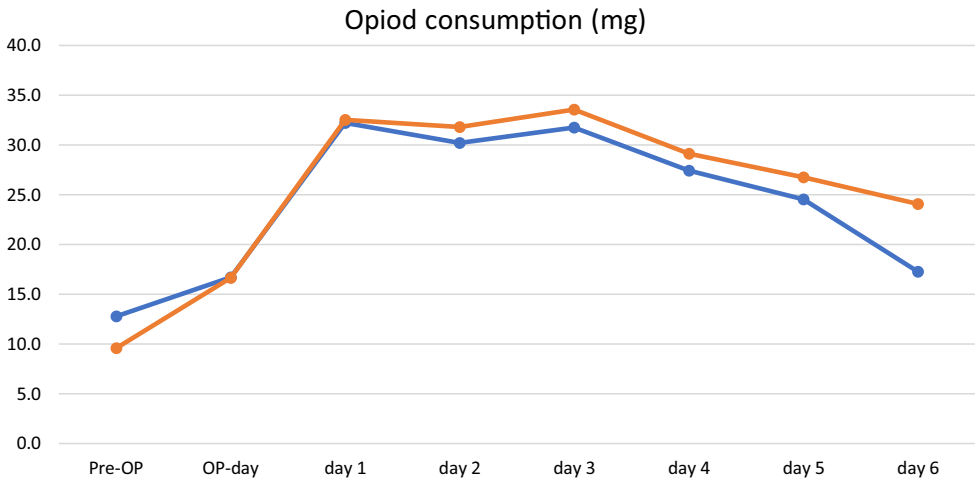

Fig. 2 Opioid consumption: intervention group (blue); control group (orange)

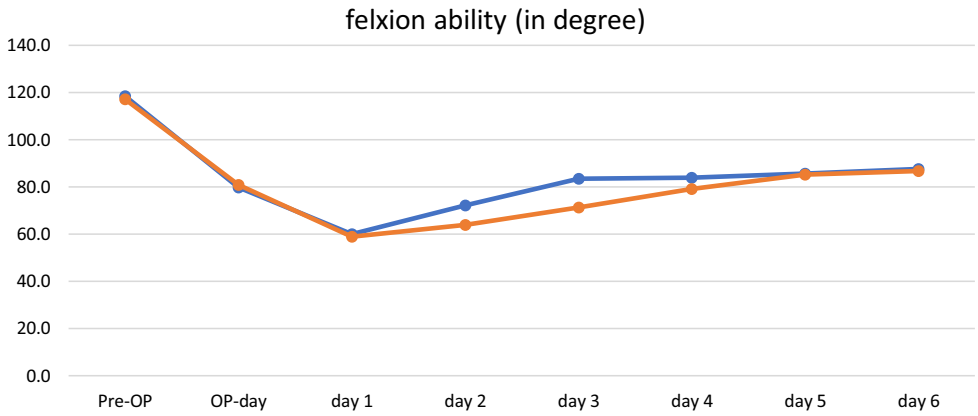

Fig. 3 Flexion ability: intervention group (blue); control group (orange)

costs involved and, of even greater importance, the risk of potential infection [1].

Postoperative pain after knee arthroplasty is usually severe and can become chronic if not addressed appropriately. The most important predictor of persistent pain seems to be the intensity of early postoperative pain [13]. Accordingly, postoperative pain management is a key factor in knee arthroplasty.

LIA has been reported to be a successful method in postoperative pain control [4, 5, 10, 14, 15]. It appears to be advantageous over traditional methods such as nerve blocks, epidural analgesia or high-dose opioid analgesia, because it blocks the pain conduction at its origin, minimizing the risks of additional side effects due to the limited systemic interference. Further, it modifies the local surgical inflammatory cascade beneficially.

However, the effect of single-shot LIA disappears within the first 24 h [1], leading to the idea of prolonging this period with an additional catheter. Therefore, this study was performed to evaluate the benefits of a periarticular catheter in combination with single-shot LIA in comparison to single-shot LIA only.

Literature about combining LIA with an intraarticular catheter seems to be inconsistent. Some authors reported that an additional intraarticular catheter did not have any clinically relevant effect [1], whereas other authors described the additional intraarticular catheter as a successful method of postoperative pain management in total knee arthroplasty, providing better pain control and improving immediate functionality while reducing postoperative opioid use [8]. Further, Essving et al. compared LIA which was infiltrated perioperatively in combination with two bolus injections via an intraarticular catheter postoperatively to intrathecal morphine after TKA and they reported the LIA technique to be superior in terms of postoperative pain, mobilization, hospital stay and patient satisfaction [6].

However, this study concerning UKA could not identify the same advantages. This might be due to the fact that the catheter had to be placed periarticular because of the potential chondrotoxicity, which might impair cartilage remaining in the compartment not substituted in UKA. Further, postoperative pain in patients receiving UKA is not usually as severe as in patients receiving TKA, because UKA is less invasive.

A common concern about LIA is the possible resorption of ropivacaine after tissue or joint infiltration with the risk of central or cardiovascular side effects. However, it has been shown that the plasma concentration of ropivacaine stayed far below the toxic threshold of 0.56 µg/ml described by Knudsen et al. [11] after performing LIA with 400 mg ropivacaine [2, 7] (like it was done in the present study). In addition, no side effects were seen in the present study.

A limitation of the present study arises from the short follow-up. Any conclusions concerning mid- or long-term results could not be drawn. However, this study focuses on the pain management in the immediate postoperative period only, since postoperative pain is usually severe and may impede early recovery. Future studies could investigate whether the use of an additional periarticular catheter has any impact on long-term results, but the authors of the present study do not expect this to be the case. Another limitation of the study is the small number of patients. However, the results are consistent so that the number of 50 patients appeared to be large enough to draw a first conclusion. A strength of the present study is that all patients had the same intra- and postoperative setting, leading to a high degree of comparability.

Postoperative pain management is an important factor in ensuring patient satisfaction and becomes even more important in view of the ongoing debate on performing knee arthroplasty in outpatient facilities.

The study showed that the risks associated with the use of a periarticular catheter cannot be justified, since any clear superiority of a periarticular catheter over single-shot LIA only in UKA in the immediate postoperative period could not be shown.

Conclusion

In summary, the present study could not identify any clear superiority of a periarticular catheter over single-shot LIA only in UKA. Due to additional costs and the possible risk of infection, it is not recommended to add a periarticular catheter to the single-shot LIA in UKA.

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Compliance with ethical standards

Conflict of interest The authors MM, PB, JH, RB declare that they have no conflict of interest. The author ET declares that he is providing consultancies for Convatec, KCI, LIMA, Medacta and Zimmer Biomet. He also declares that he receives royalties from LIMA, Medacta and Zimmer Biomet. He further declares that he is part of the European knee society board. The author JB declares that he has no conflict of interest, receives honoraria from DePuy, Conformis, Pajunk and Smith & Nephew.

Ethical approval This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the ethic committee of the local state medical council (Approv. No. F-2017-025).

Informed consent Informed consent was obtained from all individual participants included in this study.

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