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Patient-controlled regional analgesia (PCRA) with ropivacaine after arthroscopic subacromial decompression*

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Background: The aim of the study was to evaluate postoperative analgesia and safety of wound instillation of ropivacaine either by a single dose or a patient-controlled regional anaesthesia (PCRA) technique.
Methods: In 40 patients undergoing arthroscopic subacromial decompression the surgeon placed a catheter into the subacromial space at the end of the operation. In Phase I (10 patients), ropivacaine 250 mg was injected twice within 1 h. In Phase II, 30 patients were randomised into three groups: group prilocaine-ropivacaine (PR) = 20 ml of 1% prilocaine-epinephrine injected preoperatively into the subacromial bursa + 20 ml of 0.5% ropivacaine infused in the catheter postoperatively; group saline-ropivacaine (SR) = saline-epinephrine (20 ml) preoperatively + 0.5% ropivacaine as in group PR; group saline-saline (SS) = saline-epinephrine (20 ml) preoperatively + saline postoperatively. The PCRA pump was filled with local anaesthetic or saline to allow boluses of 10-ml each, maximum one bolus/h, via the catheter. Pain relief, side-effects and venous plasma concentration of ropivacaine were evaluated during a 24-h-test period.
Results: The free plasma concentration of ropivacaine was $0.12 + 0.041\ \mathrm{mg\,l^{-1}}$ in Phase I. No adverse effects were seen. In Phase II pain at rest and on movement was lower in group PR than in group SS during the first 30 min postoperatively ($P < 0.05$). Group PR had the lowest morphine consumption ($P < 0.05$). Five to seven boluses were administered via the PCRA-pump, and 20 min after administration of the study solution, pain was lower in groups PR and SR compared with group SS ($P < 0.001$).
Conclusions: Preoperative intrabursal prilocaine with epinephrine + postoperative subacromial administration of ropivacaine by PCRA-technique provided the most effective analgesia with no major side-effects. The free plasma concentrations of ropivacaine were far below toxic concentrations.

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Key words: ambulatory surgery; arthroscopic subacromial decompression; local anesthesia; regional anesthesia; ropivacaine.

Adequate pain relief is important both for the patient's well-being and to facilitate recovery (1). In order to get acceptable pain relief postoperatively, high doses of opioids may be necessary, with the subsequent risk of adverse effects, which can delay patient discharge (2). Regional anaesthesia techniques such as interscalene block have opioid sparing effects, provide excellent pain relief and increased patient satisfaction (1, 3). However, this technique can be associated with the risk of major complications (4). Wound infiltration and drain lavage with ropivacaine has been reported to be a simple, opioid-sparing method during shoulder surgery (5). We recently described a technique using an elastomeric balloon pump (Fig. 1) (Home pump®; I-Flow Corporation, Lake Forest, CA), which allows the patient to self-administer local anaesthetics directly into the operative area via a catheter – patient-controlled regional anaesthesia (PCRA) (6). However, the efficacy of this technique in providing pain relief needs to be demonstrated in controlled studies. Ropivacaine was used as local anaesthetic as it has been reported to cause less systemic toxic reaction than bupivacaine (7, 8).

The purpose of this prospective, double-blind, placebo-controlled study was to evaluate the efficacy of PCRA during a 24-h period following arthroscopic subacromial decompression. Two different techniques were evaluated. In the first part of the study

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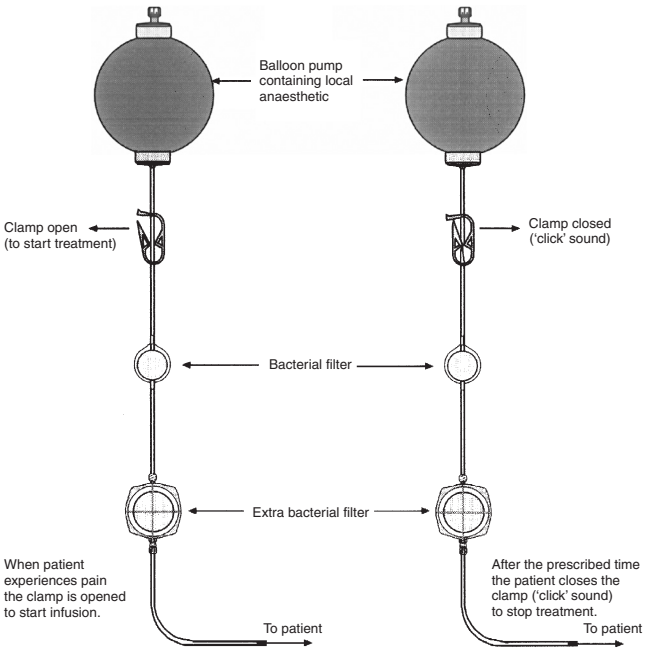

Fig. 1. When the patient experiences pain the clamp is opened (Fig. 1A) to start infusion. After the prescribed time the patient closes the clamp ('click-sound') to stop treatment(Fig. 1B).

(Phase 1, open study), a high dose of ropivacaine was administered during the first postoperative h via a catheter placed subacromially in order to study postoperative analgesia and the risk of systemic toxicity. In the second part (Phase II, randomised, double-blind), the efficacy and safety of the PCRA technique were evaluated.

Methods

Following approval by the Hospital Ethics Committee, written informed consent was obtained from 40 patients who were to undergo arthroscopic subacromial decompression (ASD) under general anaesthesia. All patients had an ASA I-II physical status and were aged 33–68 years. The exclusion criteria were chronic pain, addiction to opiod analgesics, and moderate to severe pulmonary, cardiovascular, liver, renal or psychiatric diseases. Patients were also excluded if they had difficulty in understanding or handling the pump. Midazolam 7.5–10 mg orally and paracetamol 1 g rectally were given to all patients prior to induction of anaesthesia with propofol 2 mg kg^{-1} i.v and fentanyl 1–2 μg kg^{-1} i.v. A laryngeal mask was used for assisted ventilation. Anaesthesia was maintained with oxygen in 66% nitrous oxide and isoflurane (1–2%). The patient was operated in a 'beach chair' position, using the Ellman technique (9). At the end of the operation the surgeon placed a 20G multihole epidural catheter through an epidural 18G needle (B Braun, Mellsungen, Germany) into the subacromial space under direct arthroscopic vision, ensuring that the holes of the catheter were beneath and close to the resected area of the rough subacromial bone surface. The catheter was tunnelled subcutaneously for 4–5 cm and secured on the skin with a transparent adhesive dressing (Tegaderm®) and tape.

Phase I

In the first part of the study the surgeon injected 25 ml of 1% ropivacaine (250 mg) via the catheter into the wound 10 min before termination of general anaesthesia. One h later another 25 ml of 1% ropivacaine (250 mg) was administered through the catheter (a total of 500 mg). The patients were studied during 24 h postoperatively in PACU (and continuous EKG monitoring was done) during this study period. Pulse rate, blood pressure, oxygen saturation and respiratory rate were recorded every 15 min for the first 4 h, every h for the next 2 h and every 4 h during the following 18 h postoperatively. Pain relief was assessed on a Visual Analog Scale (VAS) (0–10 cm) (0 = no pain, 10 = the worst imaginable pain) at rest and during careful movement of the upper extremity forwards and backwards. Incremental doses of morphine 1–2 mg i.v. were administered if VAS was ≥ 5 and oral dextropropoxyphene was given to the patient when VAS was <5.

Plasma ropivacaine concentration

Venous blood was sampled from a peripheral vein in the upper arm before and 30, 75, 90, 120, 150 and 180 min after the first injection of ropivacaine. The plasma was frozen within 1 h and stored at -20° until assayed. Free concentration of ropivacaine was evaluated at 75, 120 and 180 min after the first ropivacaine injection. The total concentration of ropivacaine base in the plasma samples was measured by reversed phase liquid chromatography and electrospray tandem mas spectrometry. The free plasma concentration was determined by coupled-collum liquid chromatography. The plasma concentration of alpha-1- acid glycoprotein (AAG) was determined by a radial immuno-diffusion technique at the same time intervals as the free concentration of ropivacaine was measured.

Phase II

In the second part of the trial the PCRA technique was evaluated in 30 ASA I-II patients, aged 33–68 years. The operative procedure and the type of general

anaesthesia were similar to those in Phase I. The same orthopaedic surgeon performed all operations. This was a double-blind study and the patients were randomised into three groups using computer-generated random numbers inserted into sealed envelopes.

In group PR (prilocaine-ropivacaine) 20 ml of 1% prilocaine-epinephrine was injected preoperatively, in group SR (saline-ropivacaine) 20 ml of saline-epinephrine was injected preoperatively and in group SS (saline-saline) 20 ml of saline-epinephrine was injected preoperatively into the subacromial bursa. In all patients, an epidural catheter was inserted into the subacromial area close to the rough operated bone surface at the end of the operation and a Home pump® containing 100 ml of test solution was connected via a bacterial filter. In groups PR and SR, the test solution was 0.5% ropivacaine while in group SS, the test solution was normal saline. Twenty ml of this test solution was given at the end of the operation into the subacromial bursa via the Home pump®. Both the orthopaedic surgeon and the attending anaesthesiologist were blinded to the drug assignment. All subjective measurements were obtained and recorded by an independent investigator, who was also blinded to the study drug. When the patients had postoperative pain they were asked to use the elastomeric balloon pump, Home pump® (Fig. 1), which had a remaining volume of 80 ml of either 0.5% ropivacaine or saline, providing eight doses of test drug. The contents of the elastomeric balloon would empty within 1 h if the clamp were not closed. A simple procedure of opening a clamp allowed the patients to self-administer the prescribed dose (10 ml) of local anaesthetic or saline. The patients stopped the infusion by closing the clamp after the fixed time of 6 min, which was regulated by the patient using a stopwatch. Oral as well as written instructions were given to all patients by the investigator. After the 24-h study period the investigator removed the catheter carefully and the tip was sent for bacterial culture. The elastomeric balloon pump was discarded. Pain intensity was estimated by VAS (0–10 cm) every 30 min during the first 4 h, every h during the next 2 h, and every fourth h until the study was finished. A global evaluation of the pain treatment was done using a 4-grade verbal rating scale (excellent, good, inadequate, poor) postoperatively, after 24 h. When the patient required pain relief, the infusion was started and 10 ml of the test solution was given in 6 min. The patient was instructed to avoid using the elastomeric balloon pump more than once every h. Time to the first request for analgesia was recorded. The difference in pain scores before and 20 min after the local administration of the test solution was calculated. If the patient had inadequate pain relief after the test solution had been infused, incremental doses of morphine 1–2 mg i.v. were administered if the VAS was ≥ 5 and oral dextropropoxyphene was given if the VAS was <5. Morphine and oral analgesic consumption, nausea and vomiting were recorded during the first 24 h. At the end of the test period and just before the catheter was removed, a venous blood sample was taken from a peripheral vein in the upper arm, and ropivacaine concentration was analysed in the same way as in Phase I. The patients were supervised in the PACU during the 24-h-test period and then sent home. On days 1, 2, 3 and 7 the patients were asked to answer a questionnaire about postoperative pain.

Statistics

In order to calculate the number of patients needed for this study, we looked at the anaesthetic and postoperative charts of patients in the hospital that had been operated prior to the start of the study and found a mean (SD) consumption of 14 (5) mg morphine during 24 h. We wanted to determine whether the new technique (PCRA) would reduce this by 50% (to 7 mg) during 24 h. The standardised difference was calculated to be 1.4 (difference of interest/SD) and using standard methods, we were able to determine that 20 patients would be adequate if the power was 80% and the P-value was 0.05 for two groups (10). Since we included three groups in the study, we added another 10 patients (10 patients/group), i.e. a total of 30 patients (11). Student's t-test (paired) was used to analyse the effect of the test solution before and after the opening of the elastomeric balloon pump. VAS scales were analysed using the Kruskal–Wallis test, while dichotomous data were analysed using Fisher's exact test. A P-value < 0.05 was considered to be statistically significant.

Results

The demographic data for the patients in Phase I and Phase II of the study were similar (mean age $\pm$ SD: 53 ± 10.7 and 51 ± 9.1 years, respectively). There were no significant differences in age or weight among the three groups in Phase II (mean $\pm$ SD; group PR, SR and SS age: 52 ± 8.0, 51 ± 8.9 and 51 ± 11.0 years; weight: 85 ± 12.8, 73 ± 11.3 and 78 ± 13.1 kg).

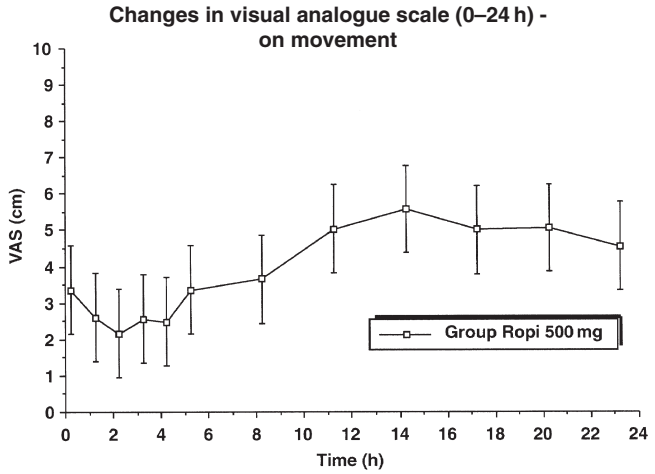

Fig. 2. The evaluation of pain by VAS scores (mean ± SD) starts just after the second injection of ropivacaine has been infused. The first dose of 250 mg was given 1 h earlier.

Phase I

The mean value of VAS was initially between 2 and 3 during mobilisation and pain relief was acceptable during a four-hour period after the first ropivacaine injection. However, after 4–6 h there was a trend toward increasing VAS scores (Fig. 2), which was not found at rest. The analgesic requirements are shown in (Table 1).

The maximum venous plasma concentration ($C_{max} \pm SD$) was $2.23 \pm 0.611\,mg\,l^{-1}$ and the peak time (T_{max}) was 111 ± 24.7 min. The C_{max} of the free (unbound) concentration was $0.12\,mg \pm 0.041\,mg\,l^{-1}$ with a range from 0.07 to $0.20\,mg\,l^{-1}$. There was a large variation in the plasma concentration of ropivacaine within the group (Fig. 3). The mean value of AAG was $18.5 \pm 3.62\,\mu mol\,l^{-1}$. There was no significant increase in the concentration of AAG during the test period. There were no significant differences in blood pressure, pulse rate or oxygen saturation compared with the baseline values. Bradycardia (pulse rate 44 and 47 beats min^{-1}, respectively) was recorded in two patients.

Phase II

All patients were able to use the elastomeric balloon pump technique easily. In one patient in Group SS, the dressing was wet after an elastomeric balloon pump infusion and the catheter was removed and discarded. This happened 15 h after the end of the operation and the patient was included in the study up to this time. Postoperative pain at rest was significantly lower in group PR than in group SS during the first 30 min postoperatively ($P < 0.05$). After 1 h the pain decreased in all three groups, so that from the fourth postoperative h, VAS was between 1 and 2 cm in all groups (Fig. 4). In all three groups pain was greater during mobilisation than at rest (Fig. 5). Pain was significantly less in group PR than in group SS during the first 30 min postoperatively ($P < 0.05$). After the second postoperative day the pain intensity decreased in all three groups on movement.

All patients used the elastomeric balloon pump technique for pain relief at least once postoperatively. The time until the first bolus was slightly longer in group PR (90/50–310 min) (median/range) than in group SR (48/40–1020 min) and group SS (60/25–80 min). However, these differences were not statistically significant. The median number of bolus doses varied between 5 and 7, without any significant differences between the groups. The variation within the groups was large, 1–8 boluses in groups PR and SR, and 3–8 boluses in group SS (NS).

At rest or on mobilisation, infusion of 10 ml of test solution via the Home pump® produced pain relief within 20 min in all groups (Table 2). During

Table 1

Postoperative analgesic requirements (0–24 h)

		Morphine			Dextropropoxyphene	
	Dose (mg) Median (range)	Patients (*n*)	Total dose (mg)	Dose (mg) Median (range)	Patients (*n*)	Total dose (mg)
Phase I						
Group R (500 mg)	1 (0–15.5)	6	32.5	300 (0–500)	9	2950
Phase II						
Group PR	0 (0–10)*	2*	19*	0 (0–300)	3	550
Group SR	2 (0–11)	6	32	0 (0–400)	5	1100
Group SS	6.5 (0–26.5)	9	83.5	50 (0–250)	4	800

The total dose of morphine and dextropropoxyphene is shown as median (range) and the number of patients (*n*) given these drugs postoperatively during 24 h. Group PR = prilocaine-ropivacaine; group SR = saline-ropivacaine; group SS = saline-saline (SS).
* = $P < 0.05$ compared to group SS.

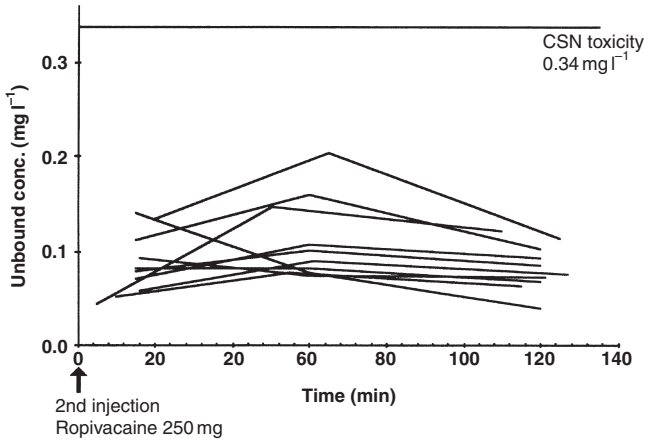

Fig. 3. Unbound (free) plasma concentration of 500 mg ropivacaine after the second injection of 250 mg ropivacaine. All individual values of the 10 concentration curves are below the concentration representing mild CNS toxicity.

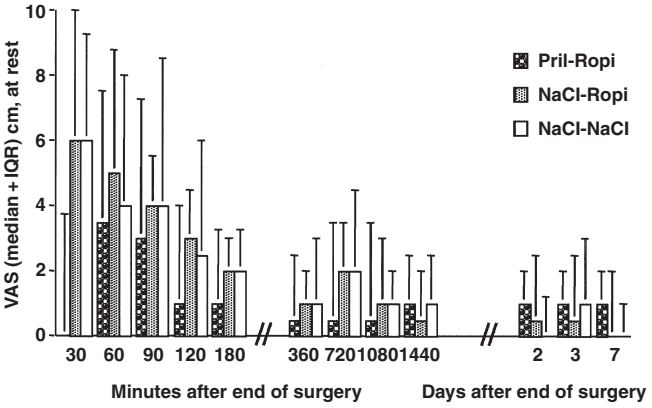

*Fig. 4. Postoperative pain (VAS) – at rest. VAS scores (median and IQR) were evaluated in hospital during the period 0–24 h and at home using a questionnaire on days 1–7. *Group PR < group SS ($P < 0.05$). Please see text for details.*

mobilisation the intensity of pain was significantly less after the Home pump® infusion of ropivacaine (groups PR and SR) than after infusion of saline (group SS); ($P < 0.001$).

Only two patients required morphine in group PR compared to nine patients in group SS ($P < 0.05$) and six patients in group SR (Table 1). The two patients in group PR required morphine after 55 min and after 12 h, respectively. In the other two groups the time to first analgesia request was 34 ± 18 min (group SR) and 66 ± 39 min (group SS) (NS). The median dose of morphine required by the patients was 0 (0–10) mg (median (range)) in group PR compared to 6.5 (0–26.5) mg in group SS ($P < 0.05$), and 2 (0–11) mg in group SR (NS).

No significant differences were found between the groups in the verbal rating score (VRS) during the first 24 h after the operation. Excellent or good postoperative pain relief was registered in nine and 10 patients in groups PR and SR, respectively, and in seven patients in group SS. One patient in the placebo group had to stay in hospital for 48 h due to severe postoperative pain.

There were no significant differences in nausea, vomiting or pruritus among the groups. In all patients the total plasma concentration after the last administration of test solution was under 0.6 mg l^{-1} and the highest individual free concentration was 0.01 mg l^{-1}. No symptoms of systemic toxicity were reported in any patient. All catheter tips were cultured. Three patients in the placebo group had an isolated growth of coagulase negative staphylococcus. Clinically, these patients had no symptoms of infection.

Discussion

With the rapid changes healthcare management systems are undergoing worldwide, more ambulatory surgery is being done, and in the 1990s ambulatory surgery constituted 60–70% of all surgery in North America (12). However, severe postoperative pain could delay discharge, and may increase unplanned admissions by as much as 8.1% (2). One of the major significant predictors of postoperative pain is the type of surgery, such as orthopaedic surgery (13). In orthopaedic patients, shoulder surgery was reported to be more painful postoperatively (38.7%) than elbow or ankle surgery (21.6% and 11.7%, respectively) (13). In the present study all patients underwent a similar type of shoulder surgery performed by one surgeon,

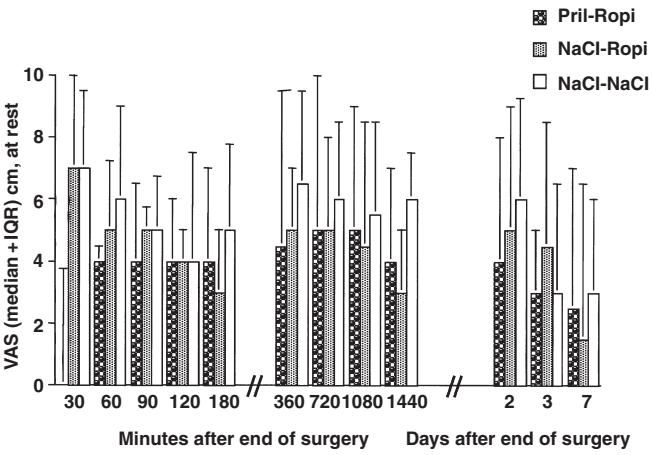

*Fig. 5. Postoperative pain (VAS) – on movement. VAS scores (median and IQR) were evaluated in hospital during the period 0–24 h and at home using a questionnaire on days 1–7. *Group PR < group SS ($P < 0.05$). Please see text for details.*

Table 2

Pain relief after Home pump® infusion			
	Pre-infusion	Post-infusion	*P*-value
At rest			
Group PR ($n=52$)	3.0 ± 2.0	1.8 ± 1.6	$P<0.0001$
Group SR ($n=56$)	3.1 ± 1.9	1.9 ± 1.9	$P<0.0001$
Group SS ($n=55$)	3.0 ± 2.1	2.2 ± 2.1	$P<0.0001$
On movement			
Group PR ($n=52$)	5.9 ± 1.5	4.7 ± 2.2*	$P<0.0001$
Group SR ($n=56$)	6.1 ± 1.5	4.8 ± 2.1*	$P<0.0001$
Group SS ($n=55$)	6.3 ± 1.5	6.1 ± 1.8	$P<0.03$

The mean $\pm$ SD of the pain intensity is shown before and after the infusion of the test solution in the three groups. Group PR = prilocaine-ropivacaine; group SR = saline-ropivacaine; group SS = saline-saline (SS). * = $P<0.001$ compared to group SS (postinfusion). Post-infusion values in all groups were significantly different from preinfusion values, both at rest and on movement.

which makes it easier to compare the effectiveness of postoperative pain relief.

The high dose of ropivacaine (500 mg) administered in Phase I was equal to the total dose available in the Home pump® technique. The venous blood concentration was low and the t-peak was late, i.e. the resorption of ropivacaine from the subacromial space was slow, which is similar to the results reported by others (5). The unbound concentration of ropivacaine was $0.12\,mg\,l^{-1}$, and the highest individual value was $0.20\,mg\,l^{-1}$, which is far below the plasma ropivacaine concentration reported to give mild CNS-symptoms in volunteers (14). In that study the maximum mean free ropivacaine concentration was $0.6\,mg\,l^{-1}$ and the lowest individual value was $0.34\,mg\,l^{-1}$. When ropivacaine was administered by PCRA-technique (Phase II), the venous blood concentration was much lower than that in Phase I. Other authors (15) have also found that the plasma concentrations are lower when using intermittent bolus injections of LA compared to continuous infusion during axillary plexus block. It was surprising that the AAG in our study did not increase during the 24-h postoperative period, which is in contrast to the findings of others (16). Nevertheless, the plasma concentration was low in all cases, irrespective of mode of administration.

In Phase I, when 500 mg of ropivacaine was given during the first postoperative h, the pain relief was satisfactory during the first 4–6 h postoperatively, following which the pain started increasing on movement, despite prompt i.v. morphine or oral dextroprophyxyphene administration. The limited duration of pain relief is consistent with the results reported by others for patients undergoing inguinal hernia repair (17) and cholecystectomy (18).

In Phase II, preoperatively, epinephrine was used in all groups to facilitate arthroscopic visualisation by reducing the risk of bleeding in the surgical field and prilocaine was used in group PR for per-operative pain relief during general anaesthesia, which is a routine in our department. During the first 30 min postoperatively, the pain relief was superior in patients in group PR, both at rest and on movement. This pain relief may have been due to the combination of intrabursal prilocaine-epinephrine administration preoperatively and the effect of ropivacaine infused 10 min before the end of the operation. The pain relief achieved in patients in group PR was good, which was based not only on low VAS scores, but also because only one patient requested morphine during the first postoperative h. Although the pain relief on movement was suboptimal in all groups according to VAS, especially in group SS, only three patients in group SS and no patient in group SR rated the pain control as inadequate or poor. In group PR the patient who rated the pain relief technique as inadequate complained that it was cumbersome and unpractical. It is likely that the patients were satisfied with the technique because they had mild pain at rest as the operated shoulder was minimally mobilised during the 24 h postoperatively.

Pain could be reduced by about 40% at rest and 20% on movement 20 min after the bolus dose of ropivacaine had been infused. These results are similar to our earlier findings in a study using the same PCRA-technique in patients undergoing hand surgery under brachial plexus block (19). The infusion of saline reduced the pain at rest by 25%, which could be considered a placebo effect (20). This could also be explained by the dilution of histamine, potassium or vaso-active polypeptides, which mediate pain (21). Although saline infusion provided a statistically significant reduction in pain intensity, the effect was mild and of limited clinical importance. In a study where continuous intrabursal infusion of bupivacaine $2.5\,mg\,h^{-1}$ combined with morphine was compared with saline postoperatively after subacromial arthroscopy (22), no difference was reported in pain caused by movement. In our study a 10-ml infusion of ropivacaine $5\,mg\,ml^{-1}$ on movement resulted in significantly lower pain scores than saline on movement ($P<0.001$). The lower local anaesthetic dose and the difference in application of the catheter can explain the differences between the two studies.

Morphine consumption was small in the ropivacaine groups (groups PR and SR) during the 24-h observation period, but especially in group PR, where only two patients required morphine. The difference in morphine consumption between the two ropivacaine groups was greatest during the first two postoperative h, probably due to the enhanced analgesic effect of prilocaine in group PR. However, it has to be emphasised that the number of patients was small in all groups, and larger studies are needed to show efficacy of this technique.

The incisional catheter technique has increasingly been used to treat postoperative pain in hospital and day-care surgery (6, 23–25). The local anaesthetic can be administered either continuously or continuously combined with PCRA (25–27). We prefer the PCRA-approach alone, as it is well documented in the literature and because the large interindividual variation in postoperative pain is difficult to predict. The advantage of the PCRA-technique is that it permits the patients not only to correct for individual variation in pain intensity, but also for the duration of analgesia after single-dose administration. The number of bolus dose administrations of local anaesthetic during the 24-h period varied from 1 to 8 doses in this study, which is consistent with the results of our previous study (19).

All patients were observed postoperatively in hospital since one group was given only saline in the home-pump, which could result in intense postoperative pain. In that group, seven of 10 patients reported excellent or good pain relief. However, in nine cases out of 10, morphine injections were required repeatedly during the 24-h-test period making it impossible for the majority of them to be discharged. In group PR, all patients could have been sent home 2 h after the operation. Since 1997 the elastomeric balloon pump technique has been used routinely at our hospital for postoperative pain management, and it has been rated as giving good/excellent pain relief in about 80% of the patients (6).

Interscalene block has been shown to be superior in comparison with subacromial bursa block after arthroscopic shoulder surgery (26). However, in that study, only one single dose of ropivacaine was given preoperatively, which is in contrast to our study. Although interscalene block reduces per- and postoperative analgesic requirement (1), when large loading doses are given, there is risk of systemic toxicity (7.6/1000) (27), block of phrenic nerve (85%-100%), recurrent laryngeal nerve (5%-20%) and sympathetic chain (12–30%) (28). The incidence of long-term complications is, however, reported to be very low with interscalene blocks (0.4%) (4).

The elastomeric balloon pump technique also has some disadvantages. There is a potential risk that the patient will fail to close the clamp. The risk of this was low in the present study as the patients were supervised in the PACU. In order to exclude any toxic consequences of this inadvertent injection, we measured the free plasma concentration of ropivacaine after the patients were given 500 mg of ropivacaine within 1 h (Phase I) which is equal in dose to the total elastomeric balloon pump volume we have used for 24 h and found that it was very low, and resulted in no toxic reactions. Although the risk of systemic toxicity is low, the number of patients in the present study is too small to draw a definite conclusion about the safety of the PCRA-technique. Probably, the technique is safer if it is applied subcutaneously or subacromially than perineurally (6).

Another risk of using indwelling catheters is wound infection. In the present study, three patients had a positive isolated culture of coagulase negative staphylococcus, which was believed to be a contaminant, as none of these patients developed any sign of infection. However, it is important to minimise the risk of infection by tunnelling the catheter subcutaneously, positioning it under sterile conditions, and using a bacterial filter.

There is a risk that the catheter can become dislodged, which happened in one patient in our study, and has also been reported by others (20–24). Better methods need to be explored in order to retain the catheter firmly in position while allowing for easy removal**.** More details about the PCRA-technique can be found in a recently published study (6). Our study was limited to 24 h, and future studies should explore the use of these devices during longer periods.

Conclusion

Wound infiltration of high bolus doses of ropivacaine (500 mg) produced no clinical symptoms of local anaesthetic toxicity. The absorption of ropivacaine was slow, and the free (unbound) concentration of ropivacaine was far below that reported to cause CNS-toxicity. Although the pain intensity on movement was mild-moderate postoperatively when the PCRA technique was used, the patients rated the pain relief as good/excellent in all cases but four, three of them in the saline group. We recommend the combination of prilocaine and epinephrine injected preoperatively in the subacromial bursa, and ropivacaine 0.5% in the elastomeric balloon pump for postoperative pain relief following arthroscopic

subacromial decompression of the shoulder since the total morphine consumption was low and the pain relief, specifically at rest, was only mild in this group.

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