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Ambulatory Surgery 9 (2001) 77–81

Ambulatory Surgery

www.elsevier.com/locate/ambsur

Two percent lidocaine spinal anaesthesia compared with sevoflurane anaesthesia in ambulatory knee surgery – cost-effectiveness, home readiness and recovery profiles

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Received 13 November 2000; accepted 1 January 2001

Abstract

A total of 60 patients scheduled for elective knee arthroscopy were randomized to receive spinal anaesthesia (SA) with 2% lidocaine ($n = 30$) or general anaesthesia with sevoflurane (SE) ($n = 30$). SA and SE were compared in terms of the total costs of anaesthesia. The time to reach home readiness and the total time spent in the recovery unit (RU) were assessed. The early postoperative period and recovery at 24 h and 1 week were evaluated in terms of the incidence of pain, sedation, nausea and general satisfaction with the method of anaesthesia and postoperative instructions. The total costs of anaesthetic materials in the operation theatre (OT) and anaesthetic materials and personnel costs until home readiness was achieved in the RU were 160.7 FIM (1 FIM = 0.17 EUR) for SA and 171.0 FIM for SE (not significant). The corresponding sums were 197.2 FIM for SA and 224.4 FIM for SE ($P = 0.001$) when the total stay in RU was considered. The time to reach home readiness was 140.8 min (S.D. 52) in the SA group and 96.4 min (S.D. 62) in the SE group ($P = 0.02$). There were no differences in the total RU time (224.0 min (S.D. 67) for SA and 218.0 min (S.D. 59) for SE). The level of postoperative pain was generally low, as all the SA patients and 86.7% of the SE patients had VAS < 4 2 h postoperatively. Six SA patients (20.0%) had postoperative headache and two of them also had headache in the supine position. There were no headaches in the SE group ($P = 0.024$). None of the patients in the SA group and six SE patients (20.0%) had nausea (needed treatment) in the RU ($P = 0.024$). Four patients (13.3%) in the SE group and 1 patient (3.3%) in the SA group had nausea during the first 24 h postoperatively. All the patients were alert 60 min postoperatively with no difference between the groups and they were very satisfied during the first 24 h. All patients would have liked to have a similar operation done on an ambulatory basis. 93.3% said they would choose the same kind of anaesthesia. 91.7% were satisfied with the first week.

General anaesthesia with SE is more cost-effective than SA with 2% lidocaine in ambulatory knee surgery if a short RU time is needed. The patients do generally well, but the incidence of postspinal headache with SA, adequate postoperative pain treatment and the possibility to have nausea with SE must be kept in mind.

Keywords: Ambulatory anaesthesia; Cost-effectiveness; Home readiness; Knee arthroscopy; Recovery; Sevoflurane; Spinal anaesthesia

1. Introduction

During the last decade, there has been an exponential growth in ambulatory anaesthesia facilitated, in part, by the introduction of new drugs and the development of anaesthetic techniques which provide rapid and predictable recovery. Although the influence of specific anaesthetic drugs on both early and late recovery times has been evaluated in a number of studies, the cost-benefit characteristics of many techniques have not been clearly established [1–3].

Spinal anaesthesia (SA) with lidocaine has been very popular in Finland among anaesthesiologists, and it has also been adopted for ambulatory surgery. During recent years, the use of lidocaine has declined because of the fear of the transient neurologic syndrome (TNS) [4]. It has been recommended that a lower dose i.e. 60 mg of lidocaine, can still be used as a spinal anaesthetic [5,6]. Previous studies [3,7,8] have shown that patients anaesthetized with 5% lidocaine have to stay in the

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0966-6532/01/$ - see front matter
PII: S0966-6532(01)00074-9

recovery unit (RU) over three times as long as patients anaesthetized with general anaesthesia (GA). That makes SA with lidocaine less cost-effective than GA [3].

The aim of this study was to compare a low-concentration (2%) lidocaine SA and general anaesthesia with sevoflurane (SE) in terms of the total costs of anaesthesia in elective ambulatory knee arthroscopy. A further purpose was to evaluate the recovery characteristics of both anaesthesias (early recovery, recovery at 24 h and recovery during the first postoperative week).

2. Methods

2.1. Patients and methods of anaesthesia

A total of 60 patients (ASA I or ASA II, age 18–65 yr) scheduled for elective knee arthroscopy were randomized to receive SA with 2% lidocaine or general anaesthesia with SE. Informed consent was obtained from each participant and the protocol was approved by the Ethics Committee of the Medical Faculty, University of Oulu.

SA ($n = 30$) was administered with 60 mg of lidocaine (1.2 ml lidocaine 50 mg/ml in 7.5% glucose) diluted with 1.8 ml of 0.9% NaCl to get 3 ml of 2% lidocaine solution. The block was induced laterally via a 27 gauge sharp-point needle inserted through the lumbar III/IV space with the patient lying on the side to be operated.

SE ($n = 30$) was anaesthetized with SE after a propofol bolus of 2 mg/kg i.v. Alfentanil 1 mg i.v. was given and the patient was relaxed with a single bolus of mivacurine 0.3 mg/kg and intubated. After that, the anaesthesia was maintained with 8% SE inhalation with a fresh gas flow of 5 l/min for 3 min. After this, the SE inhalation was lowered and the fresh gas flow was reduced to 1 l/min for all patients. The goal was to reach 1 MAC before the skin incision and to continue at that level during the operation. The patients were normoventilated ($EtCO_2$ 4.5–5.5%) with 30% oxygen in air. Alfentanil (0.5 mg) was administered for pain when needed (systolic blood pressure or heart rate rise over 20% over the baseline value). Before the operation, 100 mg of ketoprofen diluted in 20 ml of 0.9% NaCl was given to both groups. Postoperatively, all patients received 100 mg of ketoprofen i.v. or p.o. three times in 24 h and 0.05 mg of fentanyl i.v. when necessary for postoperative pain.

2.2. Postoperative period

The protocol to study the postoperative period was the same as in our previous studies [7,8]. The time of extubation, the patient's ability to open his/her eyes when asked, the ability to obey orders ('squeeze my hand') and orientation ('name and date of birth') were recorded. In the RU, vital signs were monitored regularly (HR, BP, SaO_2, alertness) at intervals of 30 min after arrival until discharge from the RU. The following parameters were recorded: degree of pain as estimated by VAS (0–10), degree of alertness (on a scale 1 = fully awake; 2 = sleepy, mostly awake; 3 = sleeps, wakeable by words; 4 = sleeps, wakeable; 5 = in coma), postoperative nausea and vomiting (PONV) (on a scale 0 = no PONV; 1 = mild PONV, no medical treatment; 2 = PONV with medical treatment; 3 = serious PONV, medical treatment ineffective). If the patient vomited or the nausea lasted for over 15 min, the patient was given metoclopramide 10 mg i.v. If the patient felt nausea after the metoclopramide dose, 4 mg of ondancetrone was given i.v. Digit Symbol Substitution Test (DSST) [9] was administered preoperatively and 60 min after the end of anaesthesia to evaluate home readiness. The following criteria for discharge were applied in both groups: alert, stable vital signs, able to ambulate, able to take oral fluids, no nausea, pain controllable by oral medication and SA patients able to void [10].

2.3. Recovery profile (after 24 h and 1 week)

On the day following discharge, the patients were asked to ascertain their nausea on an 11-point rating scale (0 no nausea, 10 worst possible nausea). The intensity of pain was evaluated as an average during the 24-h period on an 11-point rating scale (0 no pain, 10 worst pain imaginable). The patients were also asked whether they had had headache (in a supine or upright position), difficulties in voiding or abnormal sleepiness after their discharge. The patients' overall satisfaction with their general condition during the first 24 h after surgery, the timing of discharge, the anaesthesia and the postoperative pain treatment as well as their satisfaction with the staff (surgeon, anaesthesiologist and nurses) were all evaluated on an 11-point rating scale. The patients were also asked if they would be willing to have a similar procedure done in the future in an ambulatory setting and if they would have the same type of anaesthesia. The patients were asked how many hours it took postoperatively to feel as alert as they normally feel in their daily life.

After one week, the patients were asked to complete a questionnaire. They were asked about the pain during the first week, the number of days for which they needed pain medication, or if the instructions for pain treatment were adequate or inadequate. The number of readmission was recorded. The patients were also asked about discomfort during the first week (nausea, headache, backache and leg pain) and about heir overall satisfaction during the first week (0 dissatisfied, 10 totally satisfied).

2.4. Cost accounting

The direct costs [11] of the materials needed for both types of anaesthesia and the work in the operation theatre (OT) and the RU were calculated. We used the same formula for cost accounting as in our previous study in Oulu University Hospital [12]. The fixed costs [11] that remain unchanged regardless of the number of operations were ignored. The time spent in the OT and in postoperative care in the RU before discharge was recorded. The surgical team in the OT consisted of two doctors and three nurses. During the postoperative period, one nurse was able to take care of three patients. The average OT and RU salary costs per minute were calculated by dividing the total salaries with the OT and RU working hours.

The price for liquid drugs was calculated as per quantity of each drug used in millilitre. The cost of SE was calculated from the formula [12]:

$$\text{Cost in Finnish marks (FIM)} = PFTMC/2412d,$$

where P is the vaporizer concentration (Fi%), F is the fresh gas flow (l/min), T is the duration of anaesthesia (min), M is molecular weight (g), C is the cost of anaesthetic (FIM/ml), d is density (g/l).

This method of calculation assumes that the gases are delivered from the machine at an atmospheric density corresponding to 21°C, which explains the factor 2412 in the formula. M, C and d are agent-specific and are defined for SE as $M = 200$ g, $C = 3.4$ FIM/ml and $d = 1.53$ g/l.

2.5. Statistical analysis

The summary statistics for continuous variables were expressed as mean and standard deviation. The comparison between the groups was done by Student's t-test or, in a non-normal situation, by the Mann–Whitney U-test. The χ^2 or Fisher's exact test was utilized for categorical variables. The longitudinal data was analysed by analysis of variance for repeated measurements, where the preoperative value was considered as a baseline value. Significance levels are reported for comparisons with $P < 0.05$. The analyses were performed using a standard statistical program (SPSS 9.0).

3. Results

The demographic data of the groups are shown in Table 1. The variance of age was considerable and there was a tendency for the SA patients to be older than the SE patients. The study groups were comparable with regard to sex and body mass index. The duration of operation was equal, and there were no differences in the quality of operation between the two groups. The patients had similar blood-free times in the legs to be operated in both groups. The groups were also comparable with regard to the ASA risk.

3.1. Early recovery

Haemodynamically the patients did well and were stable (Table 2). There was a slight drop of both systolic and diastolic blood pressure in the SE group 5 min after the start of the operation, but this was not statististically significant. Both groups oxidized equally during the operation and postoperatively.

The SE patients were more sedated than the SA patients 30 min ($P = 0.01$) and 60 min ($P = 0.012$) postoperatively. 90 and 120 min postoperatively, there were no differences between the groups. Most of the patients were alert at that time. DSST values were equal in both groups preoperatively and at 60 min postoperatively.

The level of pain was generally low. During the first 90 min postoperatively, the median VAS was 1 for SA and 2.5 for SE. At 120 min, the median VAS for both groups was 1. All of the SA patients and 86.7% of the SE patients had VAS < 4. The need for fentanyl in the RU was 20.0% in the SA and 36.7% in the SE group.

No patients within the SA group had nausea in the RU. Six SE patients (20%) had nausea (needed treatment) in the RU ($P = 0.024$). Five patients of the SE group needed ondancetrone after metoclopramide had been given.

The time to reach home readiness was 140.8 min (S.D. 52) in the SA group and 96.4 min (S.D. 62) in the SE group ($P = 0.02$). There were no differences in the total RU time (224.0 min (S.D. 67) for SA and 218.0 min (S.D. 59) for SE).

3.2. Twenty-four hour recovery profile

All the 60 patients were contacted by phone the next day. Four patients (13.3%) in the SE group and one (3.3%) in the SA group had nausea during the first 24 h postoperatively. The overall frequency of vomiting was 3/30 in the SE group and 0/30 in the SA group.

The level of pain was generally low in both groups. 96.7% of the SA patients and 80.0% of the SE patients

Table 1
Demographic characteristics[a]

	Spinal	Sevoflurane
Number of patients (n)	30	30
Men/women (%)	50/50	60/40
Age (yr)	44.9 (11.5)	35.7 (11.8)
BMI	26.9 (3.4)	25.6 (4.4)

[a] The values are presented as means and standard deviation.

Table 2
Haemodynamic parameters (mean)[a]

		BPsyst	S.D.	Min	Max	*P*	S.D.	Min	Max	SaO_2	S.D.	Min	Max
Before operation	SA	143	19	111	191	67	13	45	103				
	SE	139	20	85	165	67	9	52	85				
5 min after anaesthesia induction	SA	134	16	100	166	64	9	48	86				
	SE	109	9	85	128	61	9	46	79				
Mean during operation	SA	133	15	104	167	64	8	50	87	98	1	95	100
	SE	109	11	85	135	62	8	50	77	98	1	96	99
Immediately postoperatively	SA	137	16	100	174	63	12	48	103	98	2	94	100
	SE	130	15	92	156	75	12	56	101	98	2	93	100
30 min postoperatively	SA	131	17	96	162	61	10	45	81	98	2	93	100
	SE	128	14	105	151	69	13	44	91	99	1	95	100
60 min postoperatively	SA	130	16	107	164	63	9	48	78	98	1	93	100
	SE	131	15	107	165	66	13	41	95	99	1	96	100
90 min postoperatively	SA	132	16	100	158	64	9	45	82	98	1	95	99
	SE	130	14	105	155	63	11	42	88	98	1	94	100
120 min postoperatively	SA	133	15	114	165	65	10	45	83	98	2	93	99
	SE	131	14	100	170	66	12	48	100	98	1	95	100

[a] Bpsyst – systolic blood pressure in mmHg, *P* – pulse beat/min, SaO_2 – oxygen saturation%.

had VAS < 4. Six patients (20.0%) in the SA group had postoperative headache, and two of them also had headache in the supine position. There were no headaches in the SE group ($P = 0.024$). The incidence of backache was 6/30 in the SA and 3/30 in the SE group. The frequencies of numbness in the lower extremities (2/30 in SA and 3/30 in SE) and pain in the thigh (3/30 in SA and 4/30 in SE) or buttock (1/30 in SA and 1/30 in SE) were very low.

The patients were very satisfied during the first 24 h. Everybody would have liked to have a similar operation done on an ambulatory basis. 93.3% would have liked to choose the same kind of anaesthesia.

3.3. Recovery during the first week

Fifty-six patients (93.3%) returned the questionnaire. 4.3% felt severe pain and the mean need for analgesics was 3.3 days. All of those who felt severe pain belonged to the SE group. 96.4% were satisfied with the pain treatment instructions. There was one readmission because of pain and swelling of the operated knee. Four SA patients had symptoms of postspinal headache (13.3%), but none of them needed a blood patch. One SE patient called the doctor about inadequate pain treatment. Three SA patients and one SE patient had pain in the contralateral leg. One SA patient and three SE patients had back pain during the first week.

The level of satisfaction was high: 91.7% felt that they were satisfied with the first postoperative week.

3.4. Costs

The costs of anaesthetic materials and RU care (material and personnel) are shown in Table 3.

4. Discussion

This study showed that it takes a significantly longer time for spinal patients to reach home readiness than SE patients. This means that SA patients need RU services for almost 45 min longer than patients given general anaesthesia with SE. In this study, we tried to reduce the amount of lidocaine to give more exactly defined anaesthesia, hoping to cut down the RU time. Although the lidocaine dose was small, but still adequate to give satisfactory anaesthesia, the effect on reducing RU time was minimal compared to our previous studies [7]. The total duration of stay in the RU in both groups (mean 221 min) was long compared to the home readiness time. The most common reason for the long stay in the RU was that the patient had to wait to be escorted from the hospital. One reason for the long RU stay may be the habit of keeping the patients in the RU for some hours to play it safe, although home readiness has been achieved.

SA is cheaper than SE, but the main cost-saving effect of SE is that SE requires a significantly shorter postoperative period, and more patients per day can

Table 3
Total anaesthetic material costs in OT and anaesthetic material and personal costs in RU

	Anaesthesia	Mean (FIM)	S.D.
Until home readiness achieved	SA	160.7	23.0
	SE	171.0	31.1
Until total discharged from RU	SA	197.2*	29.5
	SE	224.4*	29.6

* $P = 0.001$.

therefore be operated on. In previous studies, the costs of anaesthetic medication were estimated to account for less than 10% of the overall costs, while the salaries of the staff accounted for more than 85% of the total costs of anaesthesia [13]. While staff costs are difficult to reduce, overall savings may be achieved by increasing the number of cases operated per day. The cost of special anaesthetic drugs may then not be so important [14].

Some patient in the SA group had symptoms suggestive of TNS, but the number of patients was far too low to warrant any conclusion. On the other hand, the SE group had similar symptoms in the lower extremities as the SA group. One reason for this might be the patient's position during the operation and the blood-free limb. The incidence of postspinal headache was high, although none of the patients needed blood patching. The possibility to get postspinal headache and the consequent absences from work must be taken into account when calculating the total costs of different methods of anaesthesia. This aspect was not considered here.

There was a slight tendency for SE patients to have more pain than SA patients during the first postoperative week. One reason for this might be the pre-emptive analgesia caused by SA. Although the patients were generally satisfied with the postoperative pain instructions and pain management, there were too many patients in the SE group who felt severe pain. Special attention should be paid to those ambulatory patients who have had GA with short-acting opioids.

Sedation is not a problem with these patients. Nausea was moderate in the SE group, because five patients needed ondancetrone after metoclopramide had been given. Ondancetrone is an expensive drug compared to metoclopramide, which must be kept in mind when calculating the total costs.

We conclude that general anaesthesia with SE is more cost-effective than SA with 2% lidocaine in ambulatory knee surgery if a short RU time is needed. The patients are haemodynamically stable postoperatively, and the need to monitor vital parameters in the RU is short. SE anaesthesia is therefore suitable for busy units where the patient turnover is high. SA with 2% lidocaine is more cost-effective than SE then when the time spent in the RU is not important. In this series we were unable to show any connection between 2% lidocaine SA and TNS. Postspinal headache is an important side effect of SA. Adequate postoperative pain treatment and the possibility of nausea must be kept in mind when anesthetizing patients with SE.

Acknowledgements

The authors gratefully acknowledge the staff of the Ambulatory Surgery Unit of Oulu University Hospital.

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