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COMPARISON OF ANESTESIA DRUG AND SUPPLY COSTS AND EFFECTIVENESS BETWEEN GENERAL AND SPINAL ANESTHESIA FOR TOTAL OR SSUBTOTAL HIP REPLACEMENT SURGERY

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Abstract: Total or subtotal hip replacement surgeries are common orthopedic interventions which are usually performed in spinal anesthesia (SA) or general anesthesia (GA). The economic aspects of the anesthetic techniques SA or GA used for this common type of surgery are investigated only in several studies. So we investigated these two techniques and made comparison about the drugs and costs we used.
Objectives. The aim of the study was to compare the cost effectiveness of the drugs and supply used in spinal anesthesia (SA) and general anesthesia (GA) for the hip replacement surgery.
Material and method. The study was performed in Clinical Hospital Stip. The costs of drugs and supplies for anesthesia and recovery time,were analyzed in 78 patients undergoing total or subtotal hip replacement surgery receiving either spinal anesthesia (SA) or general anesthesia(GA). Anesthesia related time and pain scores during the anesthesia, in the end of the operation and in postanesthesia care unit (PACU) were also recorded.
Results. The obtained results show that total costs per case, without personnel costs, were almost half in the spinal anesthesia(SA) group compared with those in general anesthesia(GA) group. This founds were result of less costs for anesthetics and short time of recovery. There were no relevant differences regarding anesthesia-related times. Patients in the general anesthesia(GA) group were admitted to the postanesthesia care unit (PACU) with a higher pain score and needed more analgesics than patients in the spinal anesthesia (SA) group. We **conclude** that spinal anesthesia(SA) is a more cost-effective alternative to general anesthesia (GA) in patients undergoing "total and subtotal hip replacement surgeries", as it is associated with lower fixed and variable costs. Moreover, spinal anesthesia (SA) seems to be more effective, as patients in the spinal anesthesia (SA) group showed lower postoperative pain scores during their stay in the postanesthesia care unit (PACU).
Key words: spinal anesthesia, general anesthesia, anesthetic drugs, recovery, cost effectiveness

INTRODUCTION

Spinal anaesthesia is induced by injecting small amounts of local anaesthetic into the cerebro-spinal fluid (CSF). The injection is usually made in the lumbar spine below the level at which the spinal cord ends (L2). Spinal anaesthesia is best reserved for operations below the umbilicus e.g. hernia repairs, gynecological and urological operations and any operation on the perineum or genitalia. All operations on the leg are possible, but an amputation, though painless, may be an unpleasant experience for an awake patient. In this situation it may be kinder to supplement the spinal with generous sedation or a light general anaesthetic. Spinal anaesthesia is especially indicated for older patients and those with systemic disease such as chronic respiratory disease, hepatic, renal and endocrine disorders such as diabetes. Most patients with mild cardiac disease benefit from the vasodilation that accompanies spinal anaesthesia except those with stenoticvalvular disease or uncontrolled hypertension. In obstetrics, it is ideal for manual removal of a retained placenta (again, provided there is no hypovolaemia). There are definite advantages for both mother and baby in using spinal anaesthesia for Caesarean section. However, special considerations apply to managing spinal anaesthesia in pregnant patients (and it is best to become experienced in its use in the non-pregnant patient before using it for obstetrics.[1,6]
General anesthesia (GA) produces analgesia and unconsciousness. The medication is either inhaled through a breathing mask or tube, or administered through an intravenous (IV) line. A breathing tube may be inserted into the lungs to maintain proper breathing during surgery. Also the patient gets medications IV for maintenance of anesthesia. Once the surgery is complete, the anesthesiologist stops the anesthetic, the medication wears off, and the patient gradually wakes up in the operating room. Complete recovery from anesthesia continues in the recovery room.[1,6]

GOAL OF THE STUDY

The goal of this study is to test the hypothesis that less expensive and more efficient for hip replacement surgery is SA than GA.
For this purpose a retrospective analysis of 78 orthopedic cases from the orthopedic department in our Clinical Hospital, the anesthesia technique-related costs of spinal anesthesia (SA) vs. general anesthesia (GA) were compared.

METHODS

This retrospective analysis was performed at Clinical Hospital, Shtip, R. of Macedonia, on 78 orthopedic patients with total and subtotal hip replacement from the orthopedic department. The anesthesia technique-related costs for spinal anesthesia (SA) with those of GA were assessed by recording all supplies, drugs, and gases used in each case, excluding personnel costs.

During a period of one year (January - December 2014), 78 patients for hip surgery were anaesthetized in the orthopedics operating theater at our hospital. We retrospectively compared the anesthesia technique-related costs for two different types of anesthesia: SA and GA. We excluded all cases in which there were time delays or increased drugs and supply costs unrelated to the anesthesia technique. The exclusion criteria were: age of patient <18 yr, planned combination of GA and regional anesthesia technique, ASA IV patients, those with history of allergy to anesthetic drugs, history of abuse of alcohol or narcotic substances, diseases of the central nervous system and severe obstructive or restrictive pulmonary disease. Criteria for early withdrawal from the study were any surgical or anesthetic complication that necessitated prolonged tracheal intubation after surgery. Because of typical case mix in our Clinical hospital, 40% of all cases were excluded, and the remaining 78 anesthesia cases were included.

All anesthesia-related times are documented in the anesthesia record during the procedure by the anesthesia nurse in fractions of 5 min. The following time regarding staff involvement during the anesthesia cases were extracted from the anesthesia records: patient preparation and positioning by the anesthesiologist before induction of anesthesia (preparation time), anesthesia induction period which ends when the patient is ready to be positioned for the operation by the surgical staff (induction time), the procedure time including surgical positioning and preparation, surgery, and dressing (surgical procedure time), the period after the end of the surgery until the end of the anesthesia (postsurgical time/extubation), and the transfer time to the postanesthesia care unit (postanesthesia care unit transfer time)

Patients (ASA physical status I–III) undergoing Total hip replacement surgeries were enrolled in this study. Patients were premedicated with midazolam and received an infusion of 500 mL Ringer's lactate solution preoperatively. Standard monitoring (electrocardiography, noninvasive arterial blood pressure, and pulse oximetry [OXI]) was established before anesthesia. Bradycardia (<50 bpm) was treated with atropine sulfate, and hypotension (systolic arterial blood pressure [SYS], <90 mm Hg or a decrease of more than 50 mm Hg from the baseline) was treated with infusion and/or bolus application of ephedrine. Intraoperative and postoperative fluid regimes were at the anesthesiologist's discretion.

GA was induced by fentanyl (2–4 μg/kg IV) and propofol (3–5 mg/kg IV). Orotracheal intubation was done by succinil chloride 1-1,5mg/kg. Positive pressure ventilation was initiated and maintained for the duration of surgery with a tidal volume of 8 to 10 mL/kg and a ventilatory rate 12-14/min. Anesthesia was maintained with one minimal alveolar concentration of sevoflurane (age-adjusted, approximately 1.7 Vol%) and O2 3l/min and N2O 3lit/min. Maintaining of anesthesia was with doses of fentanyl 1–2 μg/kg IV every 40-45min. Sevoflurane was discontinued with the beginning of the skin sutures and the fresh gas flow was changed to 6 L/min of oxygen. The tracheal tube was removed when the patient met the criteria for tracheal extubation (spontaneous breathing with a minimum of 8 mL/kg body weight, respiratory rate >8, ability to sustain a 5-s head lift, sustained hand grip, and sustained arm lift).

SA was performed by a single-injection technique using a midline approach at the L2–3 or L3–4 interspace with a 26-gauge needle with the patient in the lateral down position. After free flow of cerebrospinal fluid, 3 mL of bupivacaine 0.5% with fentanil 1ml was injected, and the patient was turned on the back position. No adjustment in injectate volume was made for patients' height.

Urinary catheterization was performed in each patient immediately after induction of anesthesia. All patients were discharged from the operating room to the postanesthesia care unit (PACU) for recovery. Postoperative pain was evaluated with a visual analog scale (VAS) from 0 = no pain to 10 = the worst pain imaginable. Postoperative analgesia was standardized with Tramadol hydrochlorid 50-100mg IV and Ketoprofen 2ml and additional boluses of Analgin 4ml IV to achieve analgesia VAS scores of ≤3. Each variable, consciousness, activity, respiration, circulation, and oxygen saturation, was written in the patient history. PACU discharge time was measured.

Demographic data (age, sex, height, weight, ASA physical status, number of co morbidities) and the hemodynamic values (heart rate, systolic, diastolic, and mean blood pressures, and OXI) were recorded before the start of anesthesia. Hemodynamic values were recorded also at 5, 10, 15, 30, 60, 120 min after start of anesthesia and 5 min before end of anesthesia. In the PACU these values were recorded immediately at the admission and immediately before transfer to the hospital ward. Incidences of postoperative nausea and vomiting (PONV) and postoperative pain significant enough to require pharmacological treatment described above were also recorded in the PACU.

The following four time intervals were recorded: start of anesthesia to skin incision; skin incision to end of surgery; end of surgery to transfer to PACU; and PACU arrival to transfer to normal ward. Total time was defined as the duration from start of anesthesia until transfer to normal ward.[1,6,8]

The costs of anesthesia supplies, drugs, and gases used in each case were recorded during the entire procedure from the start of anesthesia to discharge from PACU. Supplies consisted of all used items, including cannulas, tubes, tubing, syringes, needles, spinal needles, fluids, and oxygen masks. Drugs consisted of all opened ampoules that one needle and one syringe of the appropriate size were used for each drug and that broken but not completely used drugs were discarded. Gas consisted of the costs for sevoflurane-app.30ml for one anesthesia case. Duration and flow rates of oxygen therapy in the PACU were not recorded and calculated as they were similar in both groups; therefore, only the costs of the oxygen mask and tubing were included. Costs for urinary catheterization were not included as it was performed in each patient. Capital equipment using was not included as all monitors and anesthetic machines were available to both groups. The costs for nursing, physician maintenance of the center, and additional patient supplies (linen and catering) were also excluded.

"Costs/min Anesthesia" was defined as total drug and supply costs (costs for anesthesia and recovery) divided through the time of intraoperative anesthesia service in minutes. We calculated the fixed and variable costs. "Fixed costs" were defined as costs that arise by induction of SA or GA anesthesia (spinal needle, local anesthetic, ventilation tubes and bag, filter, tube), whereas "variable costs" were defined as costs that are associated with maintenance of anesthesia or continuous infusion therapy (consumed narcotic gas, infusions, analgesics).[2,4,5,7,9]

Costs were calculated by an unblinded pharmacist specialist of pharmacoinformatics who was not involved in the care of any study patient.

RESULTS

78 patients were enrolled into the study (28 in GA and 50 in SA), and both groups were well matched for demographic data –weight, height, age, ASA I/II/III, comorbidities, duration of surgery (min)

Table 1. Demografic data of the study groups

Demographic data	**GA groups**	**SA groups**
Weight/kg	75±15	78±15
Height/cm	175±7	169±7
Age/years	60±10	72±10
ASA class. I/II/III	1/10/8	5/20/35
Comorbidities	2	3
Duration of surgery/min	188±35	185±30

There were no differences among the two study groups.

Total costs per case, excluding personnel costs, were 25,0 Euros in the GA group and 17,60 Euros in the SA group. Thereby, costs for anesthesia and for recovery were less with SA than with GA. Higher costs for GA were caused by both, higher variable and higher fixed costs compared with SA. Accordingly, costs per one minute of anesthesia were also more expensive in GA group.

Table 2. The cost of supplies and drugs in the groups

Anesthesia	**GA groups**	**SA groups**
Supplies	6,5	3,28
Gasses/drugs	18,5	14,38
Total(euro)	25,00	17.60
PACU	**GA groups**	**SA groups**
Drug supply	3.1	2,1

There were no clinically relevant differences regarding anesthesia-related times between groups. The induction time was shorter in the GA group; this was offset by the increased "end of surgery to transfer time" in the GA group. Time for recovery and total time were similar in both groups

Effectiveness of General and Spinal Anesthesia. Patients in the GA group were admitted to PACU with a higher pain score and needed more analgesics than patients in the SA group. Five patients in each group received antiemetic therapy with metoclopramide.

Table 3. Postoperative recovery and pain relief in the groups

	GA groups	**SA groups**
Total time (anest.+PACU)/min	1200±120	1150±100
Pain at admission to PACU/VAS	5±4	0.5±2
Tramadol/mg	350±50	150±25
Ketoprofen/ml	4±1	1±0.5

DISCUSION

GA and SA have proven to be effective anesthetic methods for patients undergoing hip replacement. No study has investigated the costs associated with both anesthetic techniques for these common surgeries. We found that hip replacement with SA is associated with significantly lower drug and supply costs for intraoperative and postoperative anesthesia service than with GA. Both anesthetic techniques showed comparable times for anesthesia, surgery, and recovery.

Although, it is a general limitation of most cost studies because institution-specific costs for drugs and supplies are used and these actual costs might be very different among hospitals and especially in among countries.

We found lower variable and fixed costs in the SA group than in the GA group; thus the economic advantage of SA increases with increasing case duration. As a further consequence, there is no intraoperative breakeven point where SA becomes more cost intensive than GA.

In addition to the decreased costs in the SA group, VAS scores at admission to PACU were less with SA than with GA, and the need for analgesics for postoperative pain therapy in the PACU with SA than with GA was also less.

Economic considerations should not influence a physician unless both methods offer a comparable medical outcome. Cost analyses must always be read with caution, as cost structure might differ among hospitals. Nevertheless, an analysis of the individual cost structure is necessary to apply the results of the current study. Another limitation of our study is that patient preferences were neglected.

CONCLUSION

We conclude that SA is associated with less fixed and variable costs and lower postoperative pain scores during the stay in the PACU. Therefore, SA is a more cost-effective alternative to GA in the immediate postoperative period for patients undergoing hip replacement. This finding is in contrast to a number of studies performed in outpatients. Further studies are necessary to determine cost-effectiveness of SA for different indications, durations of surgery, and patient collectives. The literature concerning this important issue is conflicting.

Cost aspects should never be the main focus when an anesthesia technique is chosen. However, as cost becomes increasingly important, our study may help anesthesiologists to understand the economic implications of these different techniques.

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