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Ambulatory Surgery, Vol. 3, No. 2, p. 53 1995
Elsevier Science Ltd
Printed in Great Britain

Editorial

Never mind the quality feel the width

Declared beliefs and day-to-day actions are not always congruous. Such incongruity is increasingly becoming evident in commissioners and providers of day surgery. They profess strong support for quality care and hold endless soul-searching and self-gratifying discussions on the subject. Yet in practice they set aside their quasi-religious belief in quality and bow to the forces of Mammon.

Some purchasers are demanding that 100% of certain operations are performed on an ambulatory basis. There is no procedure that can always be undertaken safely as a day case. The evidence is that overall, depending on local demographics, some 15–25% of patients with a condition suitable for day surgery are unsuitable for medical or social reasons. This percentage can be reduced by providing postoperative hotel facilities — rarely funded by purchasers — for those excluded on social grounds. But there remains a percentage of patients unfit for day surgery because of concomitant medical problems. Some purchasers demanding 100% of certain procedures on a day basis allow admission on an individual case basis. Pressure, however, is great not to claim exemptions as they may influence future purchasing.

A few providers of healthcare, responding to purchasers' demands, are also setting aside quality. There are instances where patients are being sent home following general anaesthetic day surgery although they live alone and have no-one at home to care for them. Inpatient beds are being cut to such a degree that those unsuitable for day surgery for a particular condition are having to wait inordinate lengths of time for their operations. This creates a two-tier level of care and pressure to perform day surgery on inappropriate patients. To increase their throughput of day surgery some day units are performing general anaesthetic procedures late in the evening. The evidence that this is as safe as operating during the normal working day is lacking. Inexperienced and unsupervised junior surgeons and anaesthetists are increasingly being drawn to work in day units for the same reason.

Not many years ago, day surgery was not accepted as quality treatment by many healthcare purchasers. Now, these same people, realising that it is a cost-effective form of treatment, have developed the fervour of the newly converted for day surgery. There is a grave danger that in their new-found enthusiasm they will ignore the quality issues and checks that have been carefully built up and developed by those doctors who have been involved in this field for many years. If day surgery is to survive as a form of treatment respected and accepted by the population, the quality of care given must in reality remain paramount both with the purchasers and the providers of day surgery. Corners must not be cut to achieve volume and cost savings.

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Ambulatory Surgery, Vol. 3, No. 2 pp. 55–60, 1995
Elsevier Science Ltd
Printed in Great Britain.

0966–6532(95)00003–8

Highlights from ASA panels on anaesthesia for ambulatory surgery

Anaesthesia for ambulatory surgery: postanaesthesia care unit issues

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Physicians involved in the care of the outpatient have recognized that the level of medical services rendered in the postoperative period impact on patient outcome and must be addressed with the same level of intensity as preoperative and intraoperative management. The Panel on Ambulatory Surgery: Postanaesthesia Care Unit Issues highlighted concerns related to malignant hyperpyrexia, postoperative nausea and vomiting, pain management and regional techniques, discharge criteria and patient outcome following ambulatory surgery.

Key words: Anaesthesia, postoperative recovery, ambulatory, surgery, malignant hyperpyrexia, pain, outcome

Introduction

At the recent American Society of Anesthesiologists Annual Meeting held on 15–19 October, 1994 in San Francisco, California, four panels were devoted to issues related to anaesthesia for ambulatory surgery, reflecting the increased interest in this area. Physicians involved in the care of the outpatient have recognized that the level of medical services rendered in the postoperative period impact on patient outcome and must be addressed with the same level of intensity as preoperative and intraoperative management. It is no wonder, therefore, that the Panel on Anaesthesia for Ambulatory Surgery: Postanaesthesia Care Unit (PACU) Issues, was very well attended. Chaired by Surinder K Kallar MD, Professor and Interim Chair, Department of Anesthesiology at the Medical College of Virginia, she and six other speakers discussed various topics related to this subject.

Malignant hyperpyrexia – could it be a PACU problem?

Henry Rosenberg MD, Professor and Chairman, Department of Anesthesiology at the Hahnemann University, Philadelphia, Pennsylvania addressed the issue of malignant hyperpyrexia – can it be a PACU problem? Malignant hyperpyrexia (MH) is defined as a sustained, significant hypermetabolic state, inherited as an autosomal dominant trait. In response to triggering agents, the clinical manifestations of MH are characterized by a hypermetabolic response with an increase in CO_2 production. Intraoperatively this could be detected with the use of capnography. However, in the PACU this monitoring is not routinely present. Other signs and symptoms of MH are nonspecific and the patient must be evaluated and other conditions considered in the differential diagnosis.

Does this event represent true MH or a recrudescence of MH? True malignant hyperthermia, manifesting solely in the postoperative period, was reported by the North American MH Registry in 18% of MH cases[1]. Their data suggested that patients with isolated unexplained postoperative fever may be at risk for MH-susceptibility (MHS). None of the factors examined discriminated MH negative and MHS patients. In contrast, another study reported that of 30 patients that developed postoperative fever none tested positive on muscle biopsy for MH[2]. MH muscle biopsy, although having a specificity of 80%, also has false positives. When dantrolene is administered it should be continued for 24 h intravenously because of the high incidence of recrudescence. These patients must be admitted follow-

Accepted: 25 January 1995
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ing ambulatory surgery. The presence of a high fever postoperatively may be due to an infectious or noninfectious process. Causes include sepsis, central nervous system (CNS) disturbances, endocrine and muscle disease, blood transfusion or contaminated drugs. The patient should be evaluated and appropriate laboratory tests conducted to assist in the differential diagnosis of infectious vs. noninfectious causes. A venous blood gas may show a more marked increase in CO_2. Changes in creative phosphokinase (CPK) and liver enzymes happen later in the postoperative period (4–12 h) and are not helpful in the PACU. If no triggering agents were administered during the anaesthetic, then this event was probably not MH. If the patient responded to nonspecific measures, it probably was not MH. Sudden cardiac arrest in a young patient may raise the suspicion of MH. Myoglobinuria, as the sole presenting symptom for MH, is rare. An isolated case of myoglobinuria in a paediatric outpatient raised concern about the appropriateness of performing ambulatory surgery in a MH-susceptible patient. This particular patient had a myopathy[3]. MHS (malignant hyperthermia susceptible) children may be safely discharged home after ambulatory surgery following a 4 h observation period to exclude an impending MH reaction. This could be done provided that clear guidelines regarding follow-up and management are given to parents[4].

Other conditions that may be included in the differential diagnosis of MH are: failure to awaken from anaesthesia, postoperative seizures, neuroleptic malignant syndrome and drug fever; and ascending tonic clonic seizures after myelogram. Certain dyes may cause tonic-clonic seizures after myelogram and their occurrence had not been correlated with MH. Pulmonary oedema and hypertension without a history of cardiac disease pointed more to other disorders such as pheochromocytoma, cocaine and amphetamine overdose and reversal of naloxone. Hypertension and tachycardia in an otherwise healthy patient may also be associated with cardiomyopathy. MH and MH-like syndromes could occur and differential diagnosis may be a problem. Dr Rosenberg felt that patients that are MH-susceptible receiving non-triggering agents could be discharged after ambulatory surgery.

Did the choice of anaesthesia affect the PACU stay?

The duration of stay in the PACU following ambulatory surgery was influenced both by anaesthetic choice and the facility policies dictating discharge. Rebecca S Twersky MD, Associate Professor of Anesthesiology at SUNY Health Science Center at Brooklyn addressed the effects of anaesthesia on common PACU side effects and treatments that affected the PACU stay. When regional anaesthesia was compared to general anaesthesia, less postoperative narcotics were used and the incidence of postoperative nausea and vomiting (PONV) was lower. However, no difference in actual recovery times were reported[5]. This suggested that facility factors were important determinants of PACU length of stay. The common PACU side effects following general anaesthesia of pain, dizziness, nausea and vomiting, cardiovascular alterations, urinary retention and sore throat could be modulated by anaesthetic choices. The intravenous and inhalational agents were compared for their purported advantages and disadvantages, particularly for their effects on emergence, ambulation and emetic symptoms.

Comparing midazolam and propofol for outpatient sedation, times to immediate recovery including eye opening, orientation, response to verbal command and recovery of cognitive function were faster in the propofol group with no difference in cardiorespiratory profile or time to discharge. Additionally, patients reported less pain on injection and more effective intraoperative amnesia with midazolam[6]. With the availability of flumazenil, the benzodiazepine antagonist, midazolam's use had been broadened. Recovery of cognitive function was similar at 60 min when use of midazolam-flumazenil was compared to propofol. Psychomotor function and recovery improved after flumazenil, however, patients receiving propofol had better performance on psychomotor tests and less impairment of memory[7]. There was concern about resedation following treatment with flumazenil and patients should be observed longer postoperatively, resulting in more prolonged discharge. Propofol's clear-headed emergence and faster discharge following general anaesthesia contrasted to thiopental and other sedative-hypnotics was responsible for re-assessing the mandated time spent in the PACU. Many facilities appreciated cost savings when reduced PACU stay could be translated into manpower reduction.

As expected from their lower blood gas solubilities, both desflurane and sevoflurane produced a more rapid emergence and recovery of cognitive function compared to isoflurane, halothane and enflurane[8–12]. Intravenous agents with the desirable pharmacokinetic properties of small volume of distribution, high clearance rate and short context-sensitive half-lives would result in a rapid recovery profile and potentially faster discharge.

Numerous studies have compared the intravenous and inhalational agents. When ranking the agents for their rapid emergence, orientation and time to ambulation, propofol, sevoflurane and desflurane had similar profiles compared to the longer recovery with thiopental, midazolam, isoflurane and halothane. Shorter-acting opioids like alfentanil and remifentanil (still under investigation), resulted in faster emergence than fentanyl[13,14]. However, the disadvantage of selecting a short-acting opioid was the lack of residual postoperative analgesia.

Postoperative nausea and vomiting was influenced by many factors, including surgical procedure, anaesthetic technique, pain, gender, age, time of menses cycle, previous history, or susceptibility to motion sickness. Certain anaesthetics, e.g. opioids, etomidate. N_2O and inhaled agents (including desflurane and sevoflurane) were associated with a higher incidence of PONV. The antiemetic properties of propofol[15] were clearly recog-

nized when compared to the newer inhaled agents, desflurane[16,17] and sevoflurane[18,19]. Recent research has identified receptors for neurotransmitters in the medulla that serve as mediators of nausea and vomiting. The role of serotonin or specifically, 5HT (5-hydroxytryptamine) receptors in activating the chemoreceptor trigger zone has led to the pharmacological development of antagonists of these pathways. Ondansetron and its related compounds (granisetron, and still under investigation, dolasetron) have been investigated for the prophylaxis and treatment of PONV in outpatients. In children undergoing tonsillectomy, ondansetron 0.15 mg kg^{-1} given prophylactically, significantly reduced the incidence of PONV compared to metoclopramide 0.5 mg kg^{-1} or droperidol 0.075 mg kg^{-1} [20]. Less sedation occurred with the use of ondansetron. When emetic symptoms did occur following treatment, the severity and duration of PONV were reduced. In the adult population, 4 mg iv or 16 mg orally was more effective than placebo or metoclopramide and less sedating than droperidol[21–23]. Dr Twersky concluded by saying that anaesthetic choices influenced PACU stay and the selection of the ideal ambulatory anaesthetic needed to factor in both cost considerations and desired postoperative outcome.

Postoperative pain – could we control it effectively?

Providing effective and safe analgesia postoperatively could be accomplished by using inexpensive and simple techniques. Dr Surinder Kallar and Dr Linda Jo Rice, Director of Anesthesia Research at Newington Children's Hospital, Hartford, Connecticut addressed the importance of postoperative pain management in adults and children. The incidence and severity of pain following a wide variety of ambulatory surgical procedures was recently reported by Payne et al.[24]. Twenty-six per cent of patients experienced moderate to severe pain at the time of discharge, 71% in the first 24 h following discharge. Inadequate postoperative analgesia occurred because of variability in patients' perception, reluctance to request medication, lack of preoperative education and lack of accountability for adequate pain management. Identifying variables that were correlated with postoperative pain and pain-related outcomes would allow physicians to target pain-specific therapies to ambulatory surgery patients and improve outcomes. The role of the PACU nurse had become increasingly important. Correlations were noted between pain at discharge and worst pain following discharge. Preoperative anxiety, preoperative pain expectations, preoperative sleep medication usage and preoperative pain medication usage were also correlated with worst pain following discharge. As healthcare professionals were educated about acute pain management, more effective treatments would be instituted.

Commonly-used postoperative opioids included fentanyl and alfentanil. Opioid agonist-antagonists such as butorphanol, nalbuphine and dezocine were comparable analgesics but their use was limited due to a higher incidence of nausea and vomiting. The nonsteroidal antiinflammatory drugs (NSAIDs) were currently the most studied group. Lack of respiratory depression, nausea and vomiting and physical dependence topped the list of NSAIDs' advantages over opioid analgesics. However, whether they offered narcotic-sparing effects postoperatively remains inconclusive. No difference in postoperative pain scores, narcotic requirements or length of stay in the PACU was reported when oral ibuprofen was compared to ketorolac following a variety of ambulatory procedures[25]. Higgins et al. recently reported that no difference was found in analgesic requirements or incidence of PONV when either 800 mg oral ibuprofen or 60 mg im ketorolac was compared to placebo during gynaecological laparoscopic procedures[26].

Pain management in the paediatric population required recognition of both the physical and emotional components of pain. Dr Rice emphasized that pain management was not an option, it was only a matter of what technique was utilized to achieve the desired result. Treatment choices, timing and recognizing the emotional component of pain were the keys to successful analgesic options. EMLA cream (eutectic mixture of local anaesthetics) might reduce the analgesic requirements, but the emotional component of a venipuncture or biopsy was still present. Pain treatment in children required multimodal analgesia. Regional blocks provided good analgesia, however some treatment must be in place when the analgesia wore off. Regional analgesia with or without sedation resulted in decreased PONV and faster discharge. The disadvantage of regional analgesia in children was that it might require general anaesthesia or sedation for its placement, it was limited in duration, the child might be uncomfortable about the 'numb' feeling and motor weakness might not be tolerated. Timely pain control was a shared responsibility as both nurses and physicians became educated in the options.

Preemptive analgesia could be applied by instituting analgesic modalities that were intended to inhibit nociceptive pathways of pain transmission and prevent spinal cord wind-up. What constituted effective preemptive analgesia remained controversial. The use of regional and local anaesthetic techniques was excellent for controlling postoperative pain. When compared with general anaesthesia, plasma epinephrine and serum cortisol levels and visual analogue pain scores were measurably lower at 1 h following regional anaesthesia[27]. Effective and simple regional techniques for many ambulatory procedures included splash, or wound-edge infiltrations, caudal, ilioinguinal block and upper and lower extremity blocks. Most surgical procedures could incorporate local anaesthesia wound infiltration and should be strongly encouraged. Administering local anaesthesia and/or opioids into intraarticular knee and shoulder joints, and instillation into the mesosalpinx have been evaluated. Intraarticular administration of 1 mg morphine in 0.25% bupivacaine with 1 : 200 000 epinephrine following knee arthroscopy produced lower

pain scores and less consumption of postoperative analgesics for 24 h[28]. Newer techniques reported included the use of a subphrenic catheter for postoperative analgesia after laparoscopic cholecystectomy with 0.25% bupivacaine and 1% prilocaine. This technique provided superior postoperative analgesia than systemic analgesics and patients showed faster recovery and higher vigilance scores[29]. Intercostal nerve blocks for lumpectomy with bupivacaine, or 1.5–2% lidocaine with epinephrine provided superior postoperative pain relief to general anaesthesia[30]. A multimodal or balanced analgesic therapy was the best approach for perioperative pain management (see Table 1). Intraoperatively administering a strong opioid, non-opioid, regional anaesthetic with or without adjuvants, could then be followed in the PACU by a non-opioid, weak opioid or other adjuvants. Acetaminophen, NSAIDs and opioids were used to supplement regional anaesthesia. At discharge, a modality consisting of an opioid and non-opioid, with or without adjuvants should be considered. Alternative methods included nonpharmacological methods, which were not as costly and were simple to perform. In paediatrics, these included the presence of parents, holding and rocking the child and the use of pacifiers and distraction techniques. In the adult population, alternatives included thermal packs, relaxation techniques and transcutaneous electrical stimulation.

Discharge criteria – what was the new trend?

How do you judge when a patient could be safely discharged home? Various legal and institutional requirements needed to be met. Assessing the ambulatory patient for discharge differed from the conventional inpatient evaluation. Criteria such as ambulation, hydration and voiding were not generally considered in the inpatient population. The first phase recovery generally followed the conventional Aldrete score. However, it had been suggested that the Aldrete score should replace 'colour' with oxygen saturation. Dr Frances Chung, Associate Professor of Anesthesiology and Director of Toronto Western Division Toronto Hospital, described the score she designed, intended to be a standardized approach to assessing a patient's home readiness. The Post Anaesthesia Discharge Score (PADS) was a simple cumulative index similar in concept to the Aldrete or Apgar score, which assigned a maximum of 2 points on a scale of 0–2 for the following five parameters:

1. Vital signs (blood pressure, heart rate, respiratory rate, and temperature)
2. Activity and mental status
3. Pain, nausea and/or vomiting
4. Surgical bleeding, and
5. Intake and output.

When patients had a score ≥9, they were considered to be fit for home discharge. Using the commonly-observed physical signs would avoid any additional duties for the PACU nurses. By assigning objective numerical values to these parameters, progress or lack of it became more apparent. This scoring system provided a uniform assessment for all patients and might have added medicolegal value. Using this PADS system, Chung reported that 80% of patients were able to be discharged within 1–2 h and 90% within 3 h. Further modification of the scoring system was appropriate when drinking and voiding were not required. Schreiner et al.[31] found that the incidence of vomiting was greater in children that drank postoperatively and therefore, many facilities had eliminated this criteria for discharge.

Discharge after regional anaesthesia should follow the same criteria as that for general anaesthesia. Dr Chung reported that in her institution, patients receiving spinal anaesthesia recovered within 3 h. Many patients could actually have been discharged faster, however prolonged postoperative stay occurred because of urinary retention. The patient must be fully informed about when to call a physician or return to the facility for complications such as postdural puncture headache or urinary retention. Following spinal anaesthesia, discharge could occur when there was no motor block, normal perianal pinprick sensation, plantar flexion of the foot and proprioception of the big toe.

After discharge assessment: patient's perception

Dr Beverly Philip, Associate Professor for Anesthesiology and Director, Day Surgery Unit at the Brigham and Women's Hospital, Harvard Medical School, discussed outcome after ambulatory surgery. In the largest study to date, Warner et al. reported that major morbidity and mortality within 30 days of ambulatory surgery was exceedingly rare[32]. Over 96% of the 38 598 patients were contacted for follow up. Two patients died following a myocardial infarction (MI), yielding a mortality rate of 1 : 22 545. Morbid events were reported in 31 patients: MI, 14; CNS deficits, 7; pulmonary embolism, 5; respiratory failure, 5. MI resulting in death occurred within

Table 1. Multimodal pain therapy for ambulatory surgery

Operating Room	*PACU*	*At discharge*
Strong opioids (parenteral)	Opioids (parenteral or oral)	Oral opioids
Non-opioids (NSAIDs)	Non-opioids (NSAIDs)	Oral non-opioids
Regional technique	—	—
Adjuvants (sedatives, anxiolytics)	Adjuvants	Adjuvants

7 days of surgery, one intraoperatively and the other 4 days postoperatively. Gold et al.[33] reported an unanticipated hospital admission rate of 0.9%. Pain, bleeding and intractable vomiting accounted for over 50% of admissions. Factors that were independently associated with unanticipated admission included: general anaesthesia, emesis, abdominal surgery, operating time greater than 1 h and age. Laparoscopic procedures and distance greater than 1 h from the hospital were also independently associated with hospital admission. Of patients that were discharged home the same day, Philip reported that only 38% of patients were able to return to their usual activities the day after surgery; the remainder required 3.2 ± 2.0 additional days[34]. Eighty-six per cent had more than one symptom that persisted after discharge, which included general malaise and pain. Aches, sore throat, drowsiness persisted for >3 days. Awareness was reported in 0.3% of cases. Nonetheless, 97% of patients found their ambulatory surgery experience satisfying. These findings underscored the need for better preoperative teaching and informed consent that should more carefully address common postanaesthesia sequelae. Patients and providers needed to recognize that full recovery required additional time at home. Dizziness, headache, drowsiness, sore throat and incisional pain occurred frequently, and although considered minor occurrences, were common and sometimes alarming to patients. Better preoperative education was needed to target patient, anaesthesia and surgical factors.

Aftercare – 23 h recovery, hotels, recovery centres

Dr Louis Freeman, Medical Director of the Fresno Surgery Center, Fresno, California shared his experiences in establishing alternatives for recovery and discharge following ambulatory and same day admit surgery. Recovery care centres could be incorporated into a hotel, home healthcare model, free-standing recovery centre, or an integrated ambulatory surgery unit with hospital integrated recovery. Home health models and recovery care centres could provide health services at 25% less the cost of hospitals. Home health models depended on the family, and therefore the quality was inconsistent due to the lack of continuous professional care. These cost savings did not factor in the expense to the family. Hotel plans utilized minimal professional staff and were also dependent on the family. However, the hotel plan provided more centralized equipment and availability of pharmaceuticals. The liability to facility owners made this a less attractive venture. In 1986, California licensed six recovery care facilities. They were limited to a maximum of 20 beds, geared for ASA PS 1 and 2 patients undergoing elective surgery requiring postoperative care up to 48 h. Recovery care centres provided the ambience of a residential hotel combined with professional qualified staff. In his facility all staff registered nurses must have PACU or intensive care unit (ICU) experience and were certified in advanced cardiac life support. Because the postoperative stay was limited to 48 h, it was important for anaesthesia to be consistently directed towards a rapid recovery. Pain control was addressed early and treated judiciously throughout the patient's stay. In his facility, almost all patients received patient-controlled analgesia (PCA) with fentanyl and antiemetic prophylaxis was frequently administered. Dietary advancement occurred rapidly and early ambulation and discharge was encouraged. The nursing staff's attitude was to anticipate problems and aggressively problem-solve. There was an active role for the anaesthesiologists, who remained in-house until the PACU was empty. The medical director performed daily rounds and managed analgesia, PONV and other sequelae. Hospital transfer occurred in 2.1% of patients. Dr Freeman commented that recovery care centres now seemed to have basically transformed themselves from free-standing surgery centres into licensed hospitals and may be losing the advantages of a free-standing centre. Therefore, facilities must evaluate the most cost-effective approach for providing extended postoperative care following ambulatory and same-day surgeries.

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BUTTERWORTH HEINEMANN

Ambulatory Surgery, Vol. 3, No. 2, pp. 61–63, 1995
Elsevier Science Ltd
Printed in Great Britain
0966-6532/95 $10.00 + 0.00

0966-6532(95)00004-6

Laparoscopy as a day-case procedure – the patient's view

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The acceptability to patients of laparoscopy and laparoscopic sterilization as day-case procedures and the occurrence of minor complications were evaluated by prospective questionnaire. One hundred and eight questionnaires were returned from 113 women who had a diagnostic laparoscopy and 34 questionnaires were returned from 37 women who were sterilized (95% response). Eight patients were admitted overnight. All except three women (98%) were pleased to be treated as a day case. The main reasons cited in appreciation of day case treatment were the psychological benefit of improved recovery, home comforts, convenience and easier domestic organization. Minor complications were common, of which the most significant were abdominal and shoulder pain. Despite these discomforts the majority of patients nevertheless appreciated being treated as a day case.

Key words: Laparoscopy, complications, day case, acceptability

Introduction

Recent changes in the pattern of delivery of healthcare have resulted in much greater numbers of patients being treated as day cases. As recently as 1989–9, the Audit Commission report 'A short cut to better services'[1] showed that, in the 54 district health authorities surveyed, the median performance of laparoscopies as day-case procedures was only 4.3% and the upper quartile was only 15.7%. Increasing the proportion of a procedure like laparoscopy being performed on a day-case basis has huge economic implications because it is very commonly performed and borders on the day-case/inpatient boundary rather than the day-case/outpatient boundary. However, 'better services' may imply cheaper services and not necessarily ones which are appreciated by patients as being of equal or superior quality. There is, surprisingly, little information available on the acceptability to the patient of day-case surgery. That related to all types of surgery suggests that it is popular[2–4], although reservations have been expressed after laparoscopic sterilization[5].

In recent years in the Birmingham and Midland Hospital for Women the majority of elective laparoscopies have been performed as day cases. The exceptions are those where the laparoscopy is planned as part of a treatment programme, where the patient is medically unfit, where no provision can be made for care at home with a responsible adult or where the distance from hospital (mainly referrals from other health regions) make travel on the same day impractical. This has resulted in 80% of laparoscopies for investigation or sterilization being suitable to be performed as day cases. The physiological upset associated with laparoscopy[6] makes it a challenging anaesthetic to provide good recovery and we set out to assess the side effects experienced and the patient acceptability of day-case treatment. The results were obtained as part of a randomized study of the effectiveness of oral premedication with ondansetron, metoclopramide or placebo in the prevention of postoperative nausea and vomiting[7].

Patients and methods

Following hospital ethical committee approval, written informed consent was obtained from 153 women scheduled for gynaecological laparoscopy for investigative purposes or for sterilization to be randomly allocated to receive as an oral premedication 1 h before surgery either ondansetron 4 mg, metoclopramide 10 mg or placebo. Each medication was coded and contained in identical capsules and hence the patient, nurse and investigator were unaware of which drug was administered. All women were premenopausal, had no serious concurrent medical condition and were of weight 45–75 kg. Women undergoing laparoscopy for suspected ectopic pregnancy, laparoscopic laser tubal surgery or who had a contraindication to the use of nonsteroidal anti-inflammatory drugs were excluded. Any patient with symptoms of gastrointestinal reflux was also excluded.

No other premedication was given and the patient walked from the ward to the anaesthetic room, where a standardized general anaesthetic was given by one or

Accepted: 13 March 1995
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other of the consultant anaesthetist authors. Anaesthesia was induced iv with a dose of propofol sufficient to obtund the eyelash reflex, atropine 0.6 mg and fentanyl 1.5 μg kg^{-1}. Neuromuscular blockade was produced with vecuronium 0.08 mg kg^{-1} and a laryngeal mask was inserted into the pharynx. The lungs were ventilated to normocapnia with 66% nitrous oxide and enflurane 1% in oxygen. Before surgery commenced, diclofenac 100 mg was administered rectally. The laparoscopic procedure was undertaken in a standard fashion with the peritoneal cavity being inflated with carbon dioxide 2–3 l by one of several gynaecologists. Efforts were made to empty the peritoneal cavity of carbon dioxide at the end of the procedure. Residual neuromuscular blockade was antagonized with glycopyrronium 0.5 mg and neostigmine 2.5 mg. Patients were prescribed oral codydramol (paracetamol 1 g with dihydrocodeine 20 mg) or intramuscular pethidine 50–75 mg for pain and intramuscular metoclopramide 10 mg for nausea and vomiting. The drugs were administered by nursing staff according to routine ward practices.

Patients were asked directly if they had experienced any nausea or vomiting whilst in hospital. They were also given a questionnaire to take home which asked for the symptoms of nausea, vomiting, shoulder pain, abdominal pain, headache, sore throat, dizziness and tiredness in the first 48 h following laparoscopy to be categorized as none, mild or severe. The questionnaire asked whether the patient was pleased to be treated as a day case and whether there was any particular reason for their response. A stamped addressed envelope was supplied for the return of the questionnaire.

Patient data were compared by unpaired *t* test and the incidence of symptoms was compared by χ^2 analysis. $P < 0.05$ was considered significant.

Results

Three patients were withdrawn from the study because laparoscopy was not performed as had been anticipated. Patient data on the remaining 150 women are shown in Table 1 and there were no significant differences in the age, weight, duration of anaesthesia, time from the end of the procedure to first oral intake or until discharge home between those who underwent laparoscopy or those who were sterilized. Four patients who had diagnostic laparoscopy stayed in hospital overnight, as did four who were sterilized. The reasons for admission were: patient request (two occasions); pain and vomiting; drowsiness; pain; risk of infection; haematoma formation and distance from hospital.

Of the 113 women who had a diagnostic laparoscopy, 108 returned the questionnaire and 34 of the 37 who underwent laparoscopic sterilization returned the questionnaire. Only three women said that they would have preferred to stay in hospital overnight and the reasons given were: "sore and bruised'; 'two young children' and 'would have preferred morning operation'.

The percentage of patients who suffered from symptoms in the first 48 h after leaving hospital are shown in Table 3. There were no significant differences in the incidence of any symptom between those who were sterilized and those who were not. The most commonly occurring symptoms described as of severe intensity were: abdominal pain (23% and 32%); shoulder pain (26% and 18%) and tiredness (20% and 9%).

Table 1. Patient data

	Diagnostic Laparoscopy n = *113*	*Laparoscopic sterilization* n = *37*
Age (yr)	32.0 ± 6.8	34.7 ± 5.4
Weight (kg)	60.7 ± 8.7	62.7 ± 6.5
Duration of anaesthesia (min)	21.3 ± 5.9	19.9 ± 6.2
Time to first oral intake (h)	1.8 ± 1.4	2.5 ± 1.7
Time to discharge home (h)	5.3 ± 1.8	5.7 ± 1.6

The effect of the antiemetic premedication is discussed more fully elsewhere[7] and is given in outline here. Few patients suffered from severe emetic symptoms (nausea or vomiting) after leaving hospital (Table 3). The majority of patients who experienced nausea or vomiting did so either in the recovery room or during their return to the day-case ward. After leaving hospital, nine out of 49 patients who received ondansetron premedication were nauseated which was significantly fewer than those who received placebo where 22 out of 47 patients were nauseated ($P < 0.05$).

More patients who were sterilized than those who had diagnostic laparoscopy required pethidine for postoperative analgesia (Table 4). No further analgesia other than that given intraoperatively was needed in 55% of those having diagnostic laparoscopy and a further 20% only required oral codydramol.

Discussion

The most striking finding was that performing laparoscopy as a day-case procedure was popular with the patients. Ninety-eight per cent were pleased to be treated in this way which was a similar figure to a unit performing all types of surgery[4]. This was perhaps

Table 2. Reasons volunteered for being pleased to be treated as a day case

Home comfort	13
Better for children/ domestic organization	9
Convenience	9
Family support	5
Unnecessary to stay in hospital	3
Psychological benefit/ better recovery	25
Economic for NHS	3

Table 3. Incidence (%) of symptoms

Laparoscopy (n = 108)	*None*	*Mild*	*Severe*
Shoulder pain	17	57	26
Abdominal pain	10	67	23
Headache	73	26	1
Sore throat	41	50	9
Dizziness	58	39	3
Tiredness	13	67	20
Nausea	66	25	4
Vomiting	94	4	2
Laparoscopic sterilization (n = 34)	*None*	*Mild*	*Severe*
Shoulder pain	29	53	18
Abdominal pain	6	62	32
Headache	88	12	0
Sore throat	47	53	0
Dizziness	70	27	3
Tiredness	9	82	9
Nausea	65	26	9
Vomiting	91	6	3

Table 4. Percentage of patients who received postoperative analgesia in hospital

	Laparoscopy	*Laparoscopic sterilization*
Pethidine (± codydramol)	25	57
Codydramol	20	38
None	55	5

surprising in view of the findings of the authors that laparoscopy was associated with the highest incidence of pain and nausea and vomiting after surgery. In contrast Thomas and Hare[5] found that one third of women who had chosen day care for laparoscopic sterilization subsequently wished they had stayed in hospital longer. Their survey was undertaken 1–4 months postoperatively in contrast to ours, which was prospective and one would expect the wish to have stayed in hospital to be more pronounced when questioned within 48 h. Our high day-case acceptability was in spite of an appreciable incidence of severe abdominal and shoulder pain after returning home. The findings have highlighted that our management of these symptoms deserves further attention.

It was predictable that the needs of children and domestic organization were mentioned as reasons for being pleased to go home, because this was a group who were likely to have a young family and wanted to minimize separation from them. It was interesting that such a high proportion of patients volunteered that there was a psychological benefit encouraging better recovery. The economic saving to the National Health Service illustrated the heightened awareness of the public of the financial consequences of this method of treatment.

Our unplanned admission after laparoscopy of 5% did not compare well with 1% in other series covering all types of surgery[8–11]. It could be improved by organizing laparoscopic procedures to be performed earlier in the day, allowing for a longer recuperative period for those who require it. We have the facility to admit patients relatively easily because all procedures are performed within a self-contained hospital and the two patients who wished to remain in hospital were able to be accommodated. Whilst this may not be the most economical method it does allow patients to be cared for according to their individual needs, and in their eyes receive a better quality of service.

Knowledge of the incidence of symptoms, such as sore throat, dizziness and tiredness, can help the gynaecologist and anaesthetist reassure the patient what to expect after laparoscopy. Tiredness is likely to be due to the hormonal stress response to laparoscopy[6].

Pain in the first few hours after laparoscopic sterilization is a problem and there has been a recent suggestion that the topical application of bupivacaine to the fallopian tubes is beneficial[12]. It has been commented on previously[13] that pain at the time of discharge from hospital was similar whether the patient has had sterilization or diagnostic laparoscopy and we were able to confirm that there were no significant differences on return home.

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BUTTERWORTH HEINEMANN

Ambulatory Surgery, Vol. 3, No. 2, pp. 65–70, 1995

0966-6532/95 $10.00 + 0.00

0966-6532(95)00010-0

Airway management during gynaecological laparoscopy – is it safe to use the laryngeal mask airway?

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The safety of anaesthesia for gynaecological laparoscopy probably depends largely on short operative time, close intraoperative monitoring and the experience of both anaesthetist and surgeon. However, there is debate over the most suitable mode of ventilation and form of airway management. It is argued that hypoventilation and the risk of regurgitation make intubation and ventilation mandatory, and yet spontaneous ventilation with a facemask appears to be a safe technique with reduced minor morbidity. The laryngeal mask airway (LMA) has added a new dimension to the debate since it offers potential advantages over both the tracheal tube and the facemask. The aim of this review is to analyse the physiological and clinical evidence supporting the mode of ventilation and airway management during gynaecological laparoscopy and to discuss these issues in the context of the LMA. We conclude that the physiological and clinical data available to determine the suitability of the LMA is inadequate. Further proof is required before widespread adoption of these techniques. It is possible that advances in LMA design may extend the suitability of the LMA for gynaecological laparoscopy.

Key words: Equipment, laryngeal mask, gynaecological laparoscopy, complications

Introduction

Laparoscopy was first described in 1912[1]; however the technique was virtually unknown until the mid-1960s when lighting techniques and optical systems improved sufficiently to construct suitable equipment[2]. As the new surgical technique gained momentum, the problems of anaesthesia in the presence of tension pneumoperitoneum emerged. Early laparoscopic studies reported lengthy procedures and the use of large volumes of gas to produce a pneumoperitoneum[3]. Patients were considered to be at significant risk of aspiration and hypoventilation. Intubation and positive pressure ventilation were widely recommended[3–6], a view supported by the Royal College of Obstetricians and Gynaecologists[7]. Surgeons subsequently developed greater speed and expertise and aimed to complete the procedure within 10 min and with minimal tilt[8]. The necessity for tracheal intubation fell into doubt when considering the risks of increased minor morbidity in the day surgery situation[9,10].

Thirty years after laparoscopy became established, uncertainty remains over the most suitable mode of ventilation and form of airway management. The introduction of the laryngeal mask airway (LMA) into clinical practice has added a new dimension to the debate since it offers potential advantages over both the tracheal tube and the facemask. The aim of this review is to analyse the physiological and clinical evidence supporting the mode of ventilation and airway management during gynaecological laparoscopy, and to discuss these issues in the context of the LMA.

Accepted: 13 April 1995
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Physiological changes during laparoscopy

Cardiovascular system

Tension pneumoperitoneum has a complex effect on the cardiovascular system and is influenced by several factors including the degree of Trendelenburg tilt, the intra-abdominal pressure and the ventilation technique. Blood is shunted out of abdominal organs and the inferior vena cava into central and peripheral venous reservoirs. The net effect is a minimal alteration in cardiac output with intra-abdominal pressures of 15–20 cm H_2O in healthy young females[11]. As pressures rise above 20–25 cm H_2O, however, there is marked compression of the inferior vena cava, reduced venous return and a consequent reduction in cardiac output. This fall in cardiac output leads to reflex sympathetic compensation increasing myocardial contractility, heart rate and systemic vascular resistance. The effect is made more

complex by other patient factors such as age, volume of CO_2 absorbed, intravascular volume status, associated cardiac disease and the effects of administered anaesthetic agents.

Hypercarbia may lead to an increase in dysrhythmias, particularly during halothane anaesthesia when they may occur in up to 27% of patients[12]. However, this will usually be of little clinical significance. It has been shown that spontaneous ventilation (SV) using a facemask does not lead to significant dysrhythmia during isoflurane anaesthesia[13].

Respiratory system

There is a reduction in vital capacity which is influenced by the patient's age, weight, preoperative lung function, degree of head-down tilt, administered anaesthetic agents and intraoperative ventilation techniques. Kenefick et al. have shown that spontaneous breathing through a facemask is associated with a modest hypercarbia but no acidosis or dysrhythmia during isoflurane anaesthesia[13]. Desmond and Gordon showed an increase in minute volume and respiratory acidosis caused by the steep Trendelenburg position and the pneumoperitoneum-induced splinting of the diaphragm during halothane anaesthesia[3]. Airway problems have been reported in 23% of patients breathing spontaneously through a facemask during laparoscopy[10].

Gastrointestinal system

The association of laparoscopy with increased risk of regurgitation of gastric contents is related to the lithotomy position, head down tilt, the surgeon pressing on the abdomen and insufflation of the peritoneal cavity[14]. Other possible causes of regurgitation are stimulation of the peritoneum[15,16], airway obstruction[17,18] and hiccup[19]. Epidemiological evidence from large series report a very low incidence of aspiration during laparoscopy. The Royal College of Obstetricians and Gynaecologists reported no aspiration events and one episode of regurgitation from 50 048 patients of whom an estimated 10% were managed with a facemask and the remaining 90% with a tracheal tube[7,20]. Wong reported 15 000 facemask anaesthetics[21] and Scott 2000[22] with no aspiration events.

However, there is a paucity of data regarding the incidence of regurgitation during laparoscopy and how it is influenced by tilt, intra-abdominal pressure, mode of ventilation and airway type. Duffy measured pharyngeal pH during laparoscopy and reported a 2.2% (2 : 93) incidence of regurgitation in intubated ventilated patients. Patients were placed in steep Trendelenburg tilt and given atropine, which may have interfered per se with the lower oesophageal sphincter[23,24]. Carlsson and Islander using a similar technique showed that regurgitation occurred in 20% of emergency laparoscopies[25]. Presumably this high incidence was related to the fasting status. Kurer and Welch reported no episodes of regurgitation in 120 patients, 50% of whom were managed with the facemask and spontaneous ventilation[10].

Gastroenterologists now focus on the lower oesophageal sphincter (LOS) as the major anti-reflux barrier, after finding that only manoeuvres that restore LOS competence are effective in symptomatic relief[26]. It is likely that the LOS plays an important role in preventing regurgitation during laparoscopy. The importance of the LOS in preventing regurgitation was illustrated by Valdwogel et al. who reported a 52% incidence of regurgitation via or around a gastric tube placed during laparoscopy in 226 women[27]. Jones et al. showed that the LOS is capable of rapid adaptive responses to changes in intragastric pressure during laparoscopy with maximum intraperitoneal pressures of 30 cm H_2O and a 10–15° head-down tilt, and that barrier pressure is increased or maintained[28]. Roberts and Goodman reported no episodes of reflux, as determined by an oesophageal pH probe, in 63 women undergoing gynaecological laparoscopy[19]. They suggested that insufflation may also flatten the intra-abdominal oesophagus, adding to the overall barrier pressure of the sphincter. Raised intra-abdominal pressure and Trendelenberg tilt does not therefore necessarily increase the risk of regurgitation[28]. However, Sloan et al. recently showed that in the presence of raised intra-abdominal pressure, the lower oesophageal pressure may be compromised to an extent that is clinically relevant[29].

The laryngeal mask airway

The LMA was designed by Brain in 1981 following anatomical studies of the upper airway in human cadavers[30]. Interestingly, the first published paper included 16 patients undergoing gynaecological laparoscopy without problems[31]. The LMA evolved from the search for an airway that was more practical than the facemask and less invasive than the tracheal tube. When correctly placed, the cuff portion sits in the hypopharynx at the interface between the gastro-intestinal and respiratory tracts, where it forms a circumferential low pressure seal around the glottis, thus enabling conditions suitable for controlling ventilation. This has advantages in terms of improving gas flow through the upper airway[32,33] and allowing direct access to the glottis without loss of airway control when compared to currently available oral airways. It also avoids invasion of the larynx and oesophagus[34].

Advantages over the facemask include provision of a clearer airway with improved oxygenation and a lower incidence of airway obstruction events whilst freeing the operators hands. Advantages over the tracheal tube include independence from the need to visualize directly the larynx and to produce 100% muscle relaxation, less invasion of the respiratory tract, avoidance of the risks of endobronchial or oesophageal intubation and less trauma to local tissues. Disadvantages are that the LMA does not protect the lungs from regurgitated gastric contents and is not suitable for high airway pres-

sure ventilation. Over the past 6 yr since its development, the LMA has become widely accepted worldwide as a general purpose airway with a good safety record. The majority of reviews[35 40] and editorials[41–45] consider that it has an important place in anaesthetic practice. The principal use of the LMA is in elective surgery, but it also has a role in the management of difficult intubation both as a substitute airway and as an aid to intubation[46]. To date, the LMA has been the subject of over 850 publications and has been used in at least 20 million anaesthetised patients[41].

Cardiovascular system

Laryngoscopy and subsequent tracheal intubation is associated with a 25–50% rise in blood pressure, and a similar increase in heart rate[47]. The potentially harmful effects of the acute haemodynamic stress response to conventional intubation have been well described[48,49]. Insertion of the LMA is associated with only a 0–20% rise in blood pressure and heart rate in both adults and children[50–55]. This is comparable to the facemask and Guedel airway and can be related to the avoidance of anterior structures on insertion and the lack of instrumentation of the larynx[52]. Plasma concentrations of adrenalin and noradrenalin are higher following tracheal intubation than LMA insertion[56]. Once *in situ*, it occupies a relatively afferent nerve deficient area around the glottis that is well adapted to dealing with foreign bodies such as boluses of food. Patients with an LMA require significantly less anaesthetic agent to maintain depth of anaesthesia than those who are intubated[57] and have less hypertension during emergence[58]. This benefit may extend into the postoperative period with a reduced requirement for postoperative analgesia during recovery[59]. The cardiovascular effects of general anaesthetic agents, usually hypotension and the potential for dysrhythmias, will by inference also be reduced when the LMA is used. This cardiovascular advantage of the LMA probably has little clinical significance for young, healthy women undergoing laparoscopy.

Respiratory system

Ventilation via the LMA is an effective and established technique with a good safety record and can be readily achieved during laparoscopy. Devitt et al. demonstrated that ventilation through the LMA is adequate at ventilation pressures varying from 15–30 cm H_2O and is comparable to tracheal tube ventilation[60]. The high incidence of leak in the study may be related to use of inadequately sized LMAs. Berry and Verghese reported no leaks with tidal volumes of 10 ml kg^{-1} [61], using the size 4 LMA in all normal sized adults. Van Damme assessed leak pressures in 4866 patients and showed that leak pressure of <15 cm H_2O occurred in only 2.7%[62]. Haden et al. reported using the LMA/intraoperative positive pressure ventilation (LMA/IPPV) technique on 593 occasions with only two significant clinical problems (0.3%)[63]. Over the same period there were three serious problems with the Trendelenburg tilt/intraoperative positive pressure ventilation [(TT/IPPV) (TT = trachael tube)] technique in 187 uses (1.6%). The use of the LMA with IPPV has been enhanced by development of the size 5 for larger adult patients[64].

The safe use of the LMA for controlled ventilation is further illustrated by Verghese et al.'s prospective survey of 2359 LMA anaesthetics in which 41% underwent controlled ventilation and there were no cases of aspiration[65]. This study has now been extended to over 11 000 patients, more than 4900 of whom underwent IPPV, with a similar absence of morbidity[66]. Approximately 10% of patients in Verghese's studies underwent gynaecological laparoscopy. Looking more broadly at the LMA literature, a meta-analysis of 547 LMA publications failed to show any link between IPPV and aspiration either in patients included in LMA studies (n = 12 900) or aspiration case reports (n = 10)[67].

Gastrointestinal system

Epidemiological studies indicate that the incidence of regurgitation and subsequent aspiration with the LMA is similar to that with the facemask and also the tracheal tube. A meta-analysis of published literature on the LMA to September 1993 calculated that the overall incidence of pulmonary aspiration was in the region of 2 : 10 000[67]. More recently large scale epidemiological studies have confirmed these figures. Haden et al. reported a figure of 1 : 3500[68], Van Damme 0 : 5000[62], Braun and Fritz 1 : 3000 (paediatric)[69] and Verghese et al. 1 : 11 910[66]. This compares favourably with large pre-LMA epidemiological studies have documented low incidences of perioperative pulmonary aspiration in both adults and children[70,71].

It has been suggested that reflex relaxation of the upper and lower oesophageal sphincters may be activated once the LMA cuff is inflated in the pharynx. The major implication is that such activity may predispose to regurgitation and aspiration in low risk patients, a potential cause of morbidity and mortality[15,72]. Work conducted in the 1950s demonstrated that sustained distension of the pharynx induced prolonged relaxation of the LOS[73]. There is some evidence from dye studies[74,75], one study using a pressure probe pull-through technique[76] and one using an oesophageal pH probe[77] that LOS tone may be reduced when compared to the facemask[74–76] or tracheal tube[77]. Valentine et al. compared lower oesophageal pH changes in patients managed with either the LMA or tracheal tube during IPPV. They showed a high incidence of regurgitation with the LMA during emergence, but the pH drop was small and above the commonly accepted value of 2.5[77]. This may have been related to poor timing of reversal agent or inadequate LMA size selection[78]. However, this theory remains controversial[79,80] and repeat dye[81,82] and oropharyngeal pH studies in both ventilated[83] and spontaneously breathing patients[84] have failed to

confirm these findings. The variable figures found in the different studies may simply reflect the sensitivities of the detection techniques.

It is also possible that the upper oesophageal sphincter (UOS) may assist in prevention of regurgitation of oesophageal contents during light general anaesthesia in the absence of neuromuscular blockade[16]. The presence of a mass above the UOS does not cause it to relax[85] and the mechanical features controlling the UOS are largely unknown. Vanner et al. showed that during spontaneous ventilation (SV) with no muscle relaxant, the UOS pressure does not fall significantly with an LMA in situ[86]. In comparison, non-LMA related manoeuvres such as laryngoscopy and introduction of a gastric tube through the UOS could lead to regurgitation[87,88].

Laparoscopy and the LMA

Laparoscopy is one of the most common surgical procedures and a postal survey of consultants employed by the South East Thames Regional Health Authority revealed that approximately 40% used the LMA for gynaecological laparoscopy[89]. Considering the large numbers of patients and the fact that recommendations already exist to intubate and ventilate[7], there is a remarkable lack of data demonstrating its efficacy and safety. Published trials are limited in terms of patient numbers and method of assessment of regurgitation, but they support the LMA as a safe technique both for spontaneous and controlled ventilation[90,91].

Goodwin et al. studied 40 women undergoing laparoscopy using the LMA and SV with either total intravenous anaesthesia (propofol) or inhalational anaesthesia (enflurane) and found no clinically significant cardiorespiratory differences between the two techniques[90]. There were no episodes of aspiration and no perioperative dysrhythmias. Procedures lasted approximately 15 min. Swann et al. compared controlled ventilation with the tracheal tube vs. either controlled or spontaneous ventilation via the LMA in 60 patients[91]. There were no clinically significant differences in the intraoperative conditions of the two groups, although the procedure was quicker with the LMA, with operation times averaging 10.5 min. There were no episodes of regurgitation. The incidence of dysrhythmias was low in both groups, but there was a reduced sympathetic response to LMA insertion. There were no differences in minor morbidity between the groups. No data was provided about intra-abdominal pressure or degree of tilt in either study.

The results of large-scale epidemiological studies have recently become available and support the findings of controlled trials. Malins et al. used the LMA in 3000 laparoscopy patients without producing major complications[92,93]. Verghese et al. reported its use in 1600 laparoscopy patients of whom 70% received anaesthesia through the LMA. No aspiration, regurgitation or cardiac events occurred[66].

There has been, however, one published report of pulmonary aspiration in a patient who underwent elective laparoscopic sterilization with an IPPV technique[94]. The true, unreported incidence of regurgitation is unknown and anecdotal. More significantly, 1 : 16 patients undergoing laparoscopy using the LMA/IPPV technique regurgitated dye into the pharynx, although aspiration did not occur[92].

Table 1. Suggested guidelines for use of the LMA during laparoscopy

1	Experienced LMA user
2	Meticulous selection of patients – fasted, no history of oesophageal reflux, normal lung compliance
3	Surgeon aware that the LMA is being used?
4	Select correct size of LMA: size 4 >50 kg
5	Insert the LMA when anaesthetic depth is adequate ± muscle relaxation (mivacurium, rocuronium suitable)
6	Use standard insertion technique to achieve optimal placement of the LMA
7	Either SV or IPPV – use tidal volume 8–10 ml kg^{-1}
8	Either total intravenous anaesthesia or volatile agent – avoid halothane
9	Adhere to '15' rule: <15° tilt; <15 cm H_2O IAP; <15 min duration
10	Avoid inadequate anaesthesia or muscle relaxation during surgery
11	Reverse muscle relaxant prior to termination of general anaesthesia
12	Avoid disturbance of the patient during emergence

IAP: Intra-abdominal pressure.

Conclusion

The safety of anaesthesia for gynaecological laparoscopy probably depends largely on short operative time, close intraoperative monitoring and the experience of both anaesthetist and surgeon[10]. Regardless of the concerns of sore throat and incomplete reversal of muscle relaxant, the aim of anaesthesia for laparoscopy must be to minimize the risk of aspiration and life-threatening dysrhythmias. Proving that a technique meets these criteria is logistically difficult and further larger studies, comparing the LMA with the tracheal tube and facemask, are required to better indicate the degree of tilt, the duration of procedure and patient type for which the technique may be regarded as reasonably 'safe'. The physiological and clinical data available to determine the suitability of the LMA is inadequate, but it would seem that there are reasonable grounds for experienced clinicians to use the LMA provided certain guidelines are considered (Table 1). Further proof is required before widespread adoption of these techniques. Finally, it is possible that advances in LMA design may extend the suitability of the LMA for gynaecological laparoscopy[95].

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BUTTERWORTH HEINEMANN

Ambulatory Surgery, Vol. 3, No. 2, pp. 71–73, 1995

0966-6532/95 $10.00 + 0.00

0966-6532(95)00013-5

Incidence of postoperative vomiting in ambulatory gynaecological laparoscopies, depending on anaesthesic technique employed

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A prospective, randomized and double blinded, study was performed in 120 women undergoing gynaecological laparoscopy for tubal ligation or for diagnostic purposes. The women were divided into three groups, each of which received 30 μg kg^{-1} droperidol prior to induction with thiopental in group A, propofol in group B and induction with propofol and maintenance with an infusion of propofol in group C. The patients were assessed for postoperative vomiting and also the relationship with the periods of the menstrual cycle. The use of droperidol, prior to induction with propofol and maintenance of anaesthesia with an infusion of propofol, significantly lowered postoperative emesis in gynaecological laparoscopies, but we did not find a significant relationship between the day of menstrual cycle and the occurrence of vomiting.

Key words: Gynaecological laparoscopy, postoperative complications: vomiting, anaesthesic technique

Introduction

Postoperative vomiting is a frequent complication in women undergoing gynaecological laparoscopic surgery[1–4]. Numerous factors have been implicated, such as premedication[5,6], anaesthetic technique[7,8], hormone levels[9] and sex[10].

In a recent publication, Beattie et al.[11] reported the antiemetic effect of droperidol at a 30 μg kg^{-1} dose in this type of surgery. According to these authors, this effect did not appear during the menstrual period (days 1–8 of the menstrual cycle) and vomiting was therefore more frequent at that time. However, Honkavaara et al.[12] found a higher incidence of vomiting during the luteal phase (days 20–24 of the menstrual cycle).

In this study we have evaluated the incidence of postoperative vomiting in the above-mentioned surgical procedures, taking into account the anaesthetic technique employed.

Materials and methods

One hundred and twenty women (ASA physical status I or II), who were scheduled for gynaecological laparoscopies for tubal ligation or for diagnostic purposes, were entered into the study. Age, weight, day of last menstrual cycle, pneumoperitoneum maximal pressure, pneumoperitoneum duration, anaesthesia duration and incidence of postoperative vomiting data were obtained. In the postoperative phase patients were assessed by trained personnel from the Short Stay Unit, before discharge from hospital. Those women in whom we were unable to determine the day of last menstrual cycle, those who were taking oral contraceptives, those who had given birth recently or were breast feeding, were excluded from the study.

The menstrual cycle was divided into three phases: preovulatory phase (days 1–8), ovulatory phase (days 9–16) and postovulatory phase (days 17–28).

Anaesthesia

The 120 patients were randomly assigned to one of three anaesthetic regimens (see Table 1):

Group A (control): prior to induction, 30 μg kg^{-1} droperidol, 50 μg fentanyl, 2 mg midazolam and 0.01 mg kg^{-1} atropine were administered. Induction was carried out with 5–6 mg kg^{-1} thiopental followed by 1 mg kg^{-1} succinylcholine to ease tracheal intubation. Maintenance was achieved with 2 μg kg^{-1} fentanyl, oxygen–N_2O (FiO_2 of 33%), 0.5 mg kg^{-1} atracurium and 0.5–1% isoflurane. End-tidal volume was measured continuously with a capnometer and maintained at 5–5.5%.

Group B, in which the only difference in comparison to group A was the anaesthetic induction performed

Accepted: 2 May 1995
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Table 1. Anaesthesic technique

	Premedication	*Induction*	*Maintenance*	*Reversal drugs*
Group A (control)	Droperidol 30 μg kg^{-1} Fentanyl 50 μg Midazolam 2 mg Atropine 0.01 mg kg^{-1}	Thiopental 5–6 mg kg^{-1} Succinylcholine 1 mg kg^{-1} Succinylcholine	Fentanyl 2 μg kg^{-1} O_2–N_2O FiO_2 0.33 Isoflurane 0.5–1% Atracurium 0.5 mg kg^{-1}	Atropine 0.01 mg kg^{-1} Neostigmine 1.5–2 mg
Group B	Droperidol 30 μg kg^{-1} Fentanyl 50 μg Midazolam 2 mg Atropine 0.01 mg kg^{-1}	Propofol 1.5 mg kg^{-1} Succinylcholine 1 mg kg^{-1}	Fentanyl 2 μg kg^{-1} O_2–N_2O FiO_2 0.33 Isoflurane 0.5–1% Atracurium 0.5 mg kg^{-1}	Atropine 0.01 mg kg^{-1} Neostigmine 1.5–2 mg
Group C	Droperidol 30 μg kg^{-1} Fentanyl 50 μg Midazolam 2 mg Atropine 0.01 mg kg^{-1}	Propofol 1.5 mg kg^{-1} Succinylcholine 1 mg kg^{-1}	Fentanyl 2 μg kg^{-1} O_2–air FiO_2 0.33 Propofol infusion (6 mg kg^{-1} min^{-1}) Atracurium 0.5 mg kg^{-1}	Atropine 0.01 mg kg^{-1} Neostigmine 1.5–2 mg

with propofol at 1.5 mg kg^{-1} instead of thiopental. The maintenance of anaesthesia was exactly as in group A.

Group C, in which premedication administered was the same as in groups A and B. Induction was achieved with 1.5 mg kg^{-1} propofol and maintenance with an infusion of propofol at 10 mg kg^{-1} for the first 10 min and 6 mg kg^{-1} for the remaining surgery time, oxygen–air (FiO_2 of 33%). The rest of the drugs (succinylcholine, fentanyl and atracurium) were the same as in groups A and B.

Laparoscopy was performed in all patients with abdominal insufflation and use of the Trendelenburg position.

At the end of anaesthesia, atropine 0.01 mg kg^{-1} and neostigmine 1.5–2 mg, were administered.

Data analysis

Quantitative variables (age, weight, duration of anaesthesia, etc.) were compared using Student's *t* test. Pearson's χ^2 analysis with Yate's correction were performed to compare qualitative variables (vomiting). A *P* value of 0.05 was considered significant.

Results

There were no significant differences between the three groups relating to age, weight, pneumoperitoneum maximal pressure, duration of anaesthesia, pneumoperitoneum duration and end-tidal CO_2.

Postoperative vomiting occurred in 10 patients out of 120 (8.3%). In group A (control group) six cases of vomiting occurred (15%) and in group B, four cases occurred (10%). No vomiting was observed in group C (Table 2).

With regard to the relationship of postoperative emesis in respect of the three periods into which we divided the menstrual cycle and the anaesthetic technique used, we did not find significant statistical correlation in either of the two groups in which vomiting occurred (Table 3).

Table 2. Incidence of postoperative vomiting

	No vomiting	*Vomiting*	*%*
Group A (control)	40	6	15
Group B	40	4	10
Group C	40	0	0

P C/A: <0.05.

Table 3. Incidence of vomiting related to menstrual day

	Preovulatory days (1–8)	*Ovulatory days (9–16)*	*Postovulatory days (17–28)*
Group A (control)	3	1	2
Group B	1	1	2
Group C	0	0	0

P = not significant.

Discussion

Postoperative vomiting is a common symptom after anaesthesia. Although, in general, it has been considered a minor complication, it can lead to an increased recovery time, delaying patient discharge[13]. It therefore represents an important cause of postoperative morbidity. It has been observed that patients undergoing gynaecological laparoscopic surgery suffer a high incidence of postoperative emesis, involving multiple aetiological factors[4].

Diverse studies[14–18] have proved the antiemetic effect of propofol either as an induction agent and/or maintenance drug and, likewise, the antiemetic effect of 30 μg kg^{-1} droperidol previously used for anaesthetic induction. Droperidol inhibits dopaminergic postsynaptic receptors, although the physiological basis of such antiemetic effects still remains unclear. Oestrogens have been shown to increase the number of dopaminergic receptors, and would increase nausea and vomiting especially between days 8 and 24 of the menstrual cycle,

being the period when higher levels of oestrogens could be blocked by droperidol and not during the menstruating period (days 1–8)[11].

In this study, we did not find significant differences between the three groups with regard to the three periods into which the menstrual cycle was divided, which suggested that the previous explanation of the antiemetic effect of droperidol was not the only mechanism operating. On the other hand, as reported by Green and Jonsson[19], we observed that propofol used only as an induction agent did not have a statistically significant antiemetic effect. Nevertheless we did find a statistically significant decrease of postoperative emesis ($P < 0.05$) when combining propofol as inductor and maintenance drug. When we compared the results of this study with those in which ondansetron[20–25] (a new 5-HT3 receptor antagonist) was used as antiemetic medication, we did not find minor incidences of vomiting with the particular anaesthetic techniques we used.

In conclusion, an anaesthetic technique which would minimize the risk of postoperative vomiting in ambulatory laparoscopies, would be based upon the use of 30 $\mu g\ kg^{-1}$ droperidol, prior to anaesthetic induction with propofol, followed by propofol as the only maintenance drug, being administered by continuous infusion at 10 $mg\ kg^{-1}$ for the first 10 min and 6 $mg\ kg^{-1}$ during the rest of the surgical procedure.

Acknowledgements

We would like to thank the nursing staff in the Day Surgery Unit for their assistance and Nati Ricondo for her help in preparing the manuscript.

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BUTTERWORTH HEINEMANN

Ambulatory Surgery, Vol. 3, No. 2, pp. 75–77, 1995

0966-6532/95 $10.00 + 0.00

0966-6532(95)00009-7

Laparoscopic inguinal hernia repair: quality of recovery following the use of intraperitoneal bupivacaine

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In a prospective, randomized, double-blind study in 40 adult patients undergoing laparoscopic inguinal hernia repair, we have compared the quality of recovery following intraperitoneal administration of either 0.15% bupivacaine with adrenaline 1 : 666 000 100 ml ($n = 20$) or 0.9% NaCl 100 ml ($n = 20$). Quality of recovery was assessed in terms of postoperative pain, opioid requirements, nausea and vomiting, change in bowel habit and time to discharge. Patients in the bupivacaine group compared with the saline group had significantly lower visual analogue pain scores on arrival in recovery (2.0 (1–3) vs. 5.5 (4–7.5), $P < 0.05$). Reporting of severe pain and absent-mild pain (verbal rating scale) over the 48 h period studied significantly favoured the bupivacaine group ($P < 0.05$). Postoperative morphine requirement was significantly less in the bupivacaine group (2 : 20 vs. 10 : 20, $P < 0.05$). There were no significant differences between the two groups in terms of nausea and vomiting, change in bowel habit, or duration of hospital stay. Serum bupivacaine assayed in 10 further patients did not approach accepted toxic levels. These data suggest that intraperitoneal bupivacaine, in the dosage used, is effective in reducing postoperative pain following laparoscopic inguinal hernia repair.

Key words: Surgery, inguinal hernia repair, laparoscopy; local anaesthetics, bupivacaine; anaesthetic techniques, intraperitoneal

Introduction

Inguinal hernia is a common condition occurring in 3–8% of the population. In the UK 80 000 repairs are performed annually[1]. Combining a laparoscopic approach with preperitoneal mesh repair aims to decrease both the morbidity associated with groin wounds and the convalescent time, whilst achieving a low rate of recurrence.

Quality of recovery following surgery is a major consideration, and postoperative pain may particularly limit the scope of procedures amenable to a day-case basis[2]. The use of perioperative opioids is recognized as increasing the incidence of postoperative nausea and vomiting (PONV), and potential benefits exist for the optimal use of non-steroidal anti-inflammatory drugs (NSAIDs) and local anaesthetic techniques. Intraperitoneal (ip) administration of local anaesthetic has been shown to decrease shoulder-tip pain following gynaecological laparoscopic surgery[3], but not to be effective in reducing pain after laparoscopic cholecystectomy[4]. We have investigated the effect of ip bupivacaine on the quality of recovery following laparoscopic inguinal hernia repair.

Accepted: 13 April 1995
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Patients and methods

This double-blinded, prospective study was approved by the Hospital Ethics Committee. Forty patients of ASA groups I and II who were to undergo laparoscopic inguinal hernia repair on a day-case basis were studied. All patients gave informed consent and were instructed in the use of a visual analogue pain scale. Any patient with a history of allergy to non-steroidal anti-inflammatory agents, bleeding diathesis, renal disease, asthma or peptic ulceration was excluded.

No premedication was given. All patients received a standardized anaesthetic. General anaesthesia was induced with propofol 2.0 mg kg^{-1} and vecuronium 0.1 mg kg^{-1} was given to facilitate intubation and ventilation. All patients received ketorolac 10 mg intravenously at induction. Anaesthesia was maintained with a propofol infusion 6–10 mg kg^{-1} h^{-1}, nitrous oxide (65–70%) and oxygen (30–35%). Standard monitoring was used. The anaesthetist was at liberty to adjust the propofol infusion, give further increments of vecuronium and treat any bradycardia with glycopyrrolate according to normal practice. At the end of the pro-

cedure, residual neuromuscular blockade was antagonized with neostigmine 2.5 mg and glycopyrrolate 0.5 mg. Postoperatively all patients were prescribed up to 20 mg im of morphine, if they complained of pain.

Patients were randomly allocated to one of two groups: group A (the control group) or group B (the bupivacaine/study group). All patients received a laparoscopic inguinal hernia repair, using the preperitoneal mesh technique. Having anchored the mesh and closed any peritoneal defect with staples, a sterile suction catheter was introduced into the preperitoneal space via the 5 mm trochar.

Group A received 0.9% NaCl 100 ml and group B 0.15% bupivacaine with 1 : 666 000 adrenaline 100 ml (70 ml 0.9% NaCl plus 30 ml 0.5% bupivacaine with 1 : 200 000 adrenaline). This was injected through the suction catheter, under direct vision, into the inguinal area with the patient tipped head up.

The degree of postoperative pain was assessed with a visual analogue score (VAS; 0–10 cm) and a verbal rating scale (VRS; 0 = no pain, 1 = mild pain, 2 = moderate pain, 3 = severe pain). Assessments were made at time 0 (arrival in recovery), 1 and 4 h. Further assessments were made at 12, 24 and 48 h postoperatively via return of questionnaire. Morphine requirements were assessed in the first four postoperative hours. Nausea and vomiting were assessed as present or absent and change in bowel habit interpreted as subjective diarrhoea or constipation. The time of hospital discharge was recorded.

In 10 further patients, all of whom received the study solution, venous blood samples were obtained for analysis of plasma bupivacaine levels. Samples were obtained 5, 15, 30, 60, 120, and 240 min after ip administration. Bupivacaine levels were measured using high pressure liquid chromatography (HPLC), based on the method described by Monkman, Armstrong, Flanagan, Holt and Rosevear[5]. Plasma was obtained by centrifugation and kept frozen at –20° C until assay.

Results are expressed as mean (SD); pain scores are expressed as median and percentiles. Data were analysed using the Northwick Park statistics package on an IBM-compatible computer (MS-DOS 6.2). Unpaired *t* tests and Welch's test were used for parametric data. Non-parametric data was analysed using χ^2 with Yate's correction, Fisher's exact and the Mann-Whitney *U* test. $P < 0.05$ was considered statistically significant.

Results

All patients were male. The two groups were similar with respect to age, weight, duration of operation and duration of hospital stay (Table 1).

Peak plasma bupivacaine concentrations were measured 120 min after administration (Table 2) and were below accepted toxic levels (2–4 μg ml^{-1}).

VAS pain scores at time 0 were significantly lower in the bupivacaine group compared to the saline group (Table 3). The number of patients with VRS of severe pain at any time over the 48 h period were significantly fewer in the bupivacaine group compared to the saline group. Also the number of patients with VRS of absent or mild pain over the entire 48 h period were significantly greater in the bupivacaine group compared to the saline group (Table 4). Significantly fewer patients in the bupivacaine group compared to the saline group (2 : 20 vs. 10 : 20, $P < 0.05$) required postoperative morphine. Nausea, vomiting and constipation were similar in the two groups. No patients complained of diarrhoea.

Table 1. Patient characteristics (mean (SD))

	Group A NaCl (n = 20)	*Group B bupivacaine (n = 20)*
Age (yr)	45 (14)	48 (12)
Weight (kg)	76 (8)	78 (9)
Duration of operation (min)	61 (15)	53 (13)
Duration of hospital stay (min)	298 (30)	287 (43)

Table 2. Mean (SD) plasma bupivacaine concentrations after ip administration

	Time after administration (min)					
	5	*15*	*30*	*60*	*120*	*240*
Bupivacaine (μg ml^{-1})	0	0.02 (0.04)	0.07 (0.06)	0.13 (0.05)	0.15 (0.07)	0.14 (0.09)

Table 3. Postoperative VAS pain scores following ip administration of NaCl or bupivacaine after laparoscopic inguinal hernia repair

VAS (h)	*Bupivacaine group*		*Control group*	
0	2.0	(1.0–3.0)	5.5	(4.0–7.5)*
1	2.0	(1.0–2.5)	4.0	(3.0–6.0)
4	2.0	(1.0–2.0)	4.0	(2.0–5.0)
12	2.0	(1.0–3.0)	3.5	(3.0–5.0)
24	2.0	(0.25–2.75)	3.5	(2.0–5.75)
48	1.0	(0.0–2.0)	2.0	(1.0–4.0)

Data represent median (25th and 75th percentile) scores.
* $P < 0.05$.

Table 4. Postoperative nausea, vomiting, constipation and VRS pain scores

	Bupivacaine group (n)	*Control group* (n)
Nausea	3	5
Vomiting	1	1
Constipation	6	5
VRS 0 or 1 (over entire 48 h period)*	13	2
VRS 3 (at any time over 48 h period)*	1	6

* $P < 0.05$
(*n*) = No. of patients.

Discussion

Laparoscopic inguinal hernia repair had an uncertain beginning because of the variety of surgical techniques initially described. However, the placement of preperitoneal patches of non-absorbable mesh using either a transperitoneal or a preperitoneal approach, is now emerging as the repair of choice[6]. Stoker, Spiegelhalter, Singh and Wellwood have reported that laparoscopic repair induces less pain than open repair, and enables patients to return to normal activity and work more quickly[7]. Jago has highlighted the amenability of this technique to day-case surgery and predicted a low recurrence rate[8].

The administration of intraperitoneal local anaesthetic has produced conflicting results. Narchi, Benhamou and Fernandez first described its use in reducing shoulder pain after diagnostic laparoscopy[3]. They subsequently demonstrated that the addition of adrenaline (1 : 320 000–1 :800 000) to the local anaesthetic solution significantly decreased peak serum local anaesthetic concentration (C_{max}) and the time to reach the peak (t_{max})[9]. Ip administration of 20 ml of 0.25% plain bupivacaine did not reduce postoperative pain following laparoscopic cholecystectomy. This may have been an ineffectively low dose of plain bupivacaine.[4]

NSAIDs have been shown to be effective in reducing post-laparoscopy pain[10]. Although the initial recommended dose of ketorolac has been reduced from 30–10 mg, its early efficacy may be similar[11]. The avoidance of opiates and the utilization of propofol infusions aim to minimize postoperative nausea and vomiting in day-case surgery.

This study would have been improved by assessing postoperative pain during patient movement[12]. In addition, laparoscopic port entry sites were not infiltrated with local anaesthetic which is recommended[13]. However, the results of this study suggest that the ip administration of 100 ml 0.15% bupivacaine with 1 : 666 000 adrenaline is effective in reducing postoperative pain and the requirement for supplementary opiate analgesia following laparoscopic inguinal hernia repair.

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Ambulatory Surgery, Vol. 3, No. 2, pp. 79–82 1995

0966-6532/95 $10.00 + 0.00

0966-6532(95)00007-0

Postoperative pain control in paediatric ambulatory herniorrhaphy and orchiopexy using atraumatic intraoperative instillation of bupivacaine in comparison with rectal application of acetaminophen: a double-blind study

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Herniorrhaphy and orchiopexy are increasingly performed on an outpatient basis in paediatric surgery. In such cases, postoperative analgesia should receive special attention so that the hospital stay need not be unnecessarily prolonged due to side effects of the analgesic agents, such as sedation, respiratory depression or vomiting. Therefore, the present study is a randomized double-blind investigation to assess the effectiveness of atraumatic intraoperative instillation of bupivacaine in the surgical site and the rectal application of acetaminophen as a postoperative analgesic following herniorrhaphy and orchiopexy. Male patients between the ages of 3 and 6 yr who were scheduled to receive ambulatory herniorrhaphy or orchiopexy were included in the study. One hundred children in each of the herniorrhaphy and orchiopexy groups were treated respectively with acetaminophen or with bupivacaine as the postoperative analgesic. Atraumatic intraoperative instillation of bupivacaine into the surgical site proved to be significantly superior as a postoperative analgesic in both the herniorrhaphy and orchiopexy groups as compared to rectal application of acetaminophen (χ^2 test: herniorrhaphy group $P < 0.05$; orchiopexy group $P < 0.001$). For herniorrhaphy and orchiopexy in childhood, local atraumatic instillation of bupivacaine during surgery into the wound bed is a simple, easy to use and reliable method for postoperative pain control with no side effects.

Key words: Ambulatory paediatric surgery, orchiopexy, herniorrhaphy, postoperative pain control, bupivacaine, acetaminophen

Introduction

Herniorrhaphy and orchiopexy in paediatric surgery are increasingly performed on an outpatient basis[2]. The advantages of ambulatory surgery are not only its cost effectiveness, but also the lower rate of wound infections[3] and the obviation of separating the patient from his mother and family. Within several hours after surgery, the children can leave the hospital again. Postoperative analgesia should receive special attention in these cases, so that the hospital stay need not be unnecessarily prolonged due to the possible side effects of analgesia, such as sedation, respiratory depression or vomiting. The present study therefore investigates the effectiveness of the atraumatic intraoperative instillation of bupivacaine in the surgical site and the rectal application of acetaminophen as postoperative analgesics following herniorrhaphy and orchiopexy in the form of a randomized double-blind study.

Accepted: 13 April 1995
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Patients and methods

The investigation originally began as a placebo-controlled, randomized double-blind study accepted by the Ethics Commission of the University of Tübingen. However, this study was terminated after assessing a

small number of patients because we sometimes had horrible experiences in the recovery room (with patients in the placebo group). Consequently, we resumed the study as a randomized double-blind investigation without a placebo group.

The study included male patients between the ages of 3 and 6 yr who were scheduled to undergo ambulatory herniorrhaphy or orchiopexy.

Herniorrhaphy group (n = 200)

Group A: bupivacaine (n = 100)
When the children were waiting in the operating room, each received a placebo suppository. The intraoperatively exposed portion of the ilioinguinal nerve was moistened with 0.066 ml of bupivacaine 0.25% kg^{-1} bw. After subcutaneous suture, the wound edges were also moistened with 0.033 ml of bupivacaine 0.25% kg^{-1} bw.

Group B: acetaminophen (n = 100)
When the children had been called to the operating room, they all received 15–20 mg acetaminophen kg^{-1} bw as a rectal suppository. The ilioinguinal nerve as well as the wound edges were moistened intraoperatively with equivalent amounts of 0.9% saline solution.

Orchiopexy group (n = 200)

Group C: bupivacaine (n = 100)
For the most part the same procedure as used in Group A was followed, but with the additional instillation of 0.5–1.0 ml bupivacaine into the scrotal incision.

Group D: acetaminophen (n = 100)
For the most part the same procedure as used in Group B was followed, but with the additional scrotal application of 0.5–1.0 ml 0.9% saline solution.

Table 1 shows a summary of the procedures applied in the herniorrhaphy and orchiopexy groups. The children were postoperatively monitored at regular intervals, initially in the recovery room and then on the ward. They were asked about pain complaints in the presence of their parents.

Results

Herniorrhaphy

Group A: Ninety-three of the 100 children had no pain, three complained of weak pain and four of strong pain. These four children received 15–20 mg acetaminophen kg^{-1} bw rectally.
Group B: Eighty-four of the 100 children had no pain, five complained of weak pain and 11 of strong pain. These 11 children received an additional rectal dose of acetaminophen.

Orchiopexy

Group C: Ninety-one of the 100 children had no pain, two complained of weak pain and seven of strong pain. These seven children received acetaminophen rectally.
Group D: Sixty-two of the 100 children had no pain, six experienced weak and 32 strong pain. These 32 children received acetaminophen rectally.

With regard to pain relief, the χ^2 test produced significant differences in both the herniorrhaphy (P <0.05) and orchiopexy groups (P <0.001) showing bupivacaine to be superior.

Discussion

The systematic assessment of pain in infancy and early childhood is not only a difficult task but also extremely controversial[6]. We therefore consciously excluded these age groups and the recommended methods, asking instead 3–6-yr-old boys in the presence of their parents about the intensity of postoperative pain.

The advantages of postoperative pain control using analgesics with peripheral action, for example, acetaminophen, result from the simple application form of the suppository and from the paucity of side effects if

Table 1. Methods of postoperative pain control

	Herniorrhaphy (n = 200)		*Orchiopexy (n = 200)*	
	A (n = 100)	*B (n = 100)*	*C (n = 100)*	*D (n = 100)*
Preoperatively	Placebo supp.	Rectal 15–20 mg acetaminophen kg^{-1} bw	Placebo supp.	Rectal 15–20 mg acetaminophen kg^{-1} bw
Intraoperatively	Inguinal instillation 0.1 ml bupivacaine 0.25 % kg^{-1} bw	Inguinal instillation 0.1 ml 0.9 % saline kg^{-1} bw	Inguinal instillation 0.1 ml bupivacaine 0.25% kg^{-1} bw plus 0.5–1.0 ml scrotal bupivacaine 0.25%	Inguinal instillation 0.1 ml 0.9% saline kg^{-1} bw plus 0.5–1.0 ml scrotal 0.9% saline

Table 2. Possible regimens of postoperative pain control following herniorrhaphy and orchiopexy (summary)

Form of analgesia/ dosage	*Side effects*	*Complications*	*Advantages/ disadvantages*
Acetaminophen 15–20 (–50) mg kg^{-1} bw rectally, maximum 4 (3) times daily	Resorption times up to 4 h; rare: urticaria, bronchospasm	Haemolytic anaemia (G-6-P-DHG deficiency) Possible result of overdose: acute liver failure!	Easy application, can be continued at home without difficulty; only moderate analgesia
Opiates (titrated postop. iv application) Piritramid: 0.1–0.3 mg kg^{-1} bw Nalbuphine: 0.1–0.25 mg kg^{-1} bw	Sedation, nausea, vomiting. Rare: CNS effects (nervousness, dysphoria) cardiopulmonary actions, gastrointestinal effects, erythema, pruritus	Respiratory depression, acute longer postop. asthma attack (nalbuphine: sodium disulfide as solvent!)	Good analgesia; monitoring necessary; iv cannula should be left in situ
Caudal Anaesthesia Bupivacaine 0.25% For herniorrhaphy 1 ml kg^{-1} bw For orchiopexy 1.25 ml kg^{-1} bw (max. 20 ml, alternatively 0.15–0.2% solution)	Urinary retention, motor neural block (minimal using bupivacaine 0.125% with good analgesia (24))	Rare: Neural lesion, haematoma, infection at puncture site, perforation of dura. Intraosseous injection produces high plasma levels	Very good analgesia, reduction of anaesthetic agents when applied preoperatively; occasional technical problems with construction
Nerve blocks Bupivacaine 0.5% (ilioinguinal and femoral iliohypogastric nerves): 0.5 mg kg^{-1} bw = 0.1 ml kg^{-1} bw per nerve	Rare: Transitory paralysis of the nerve with gait difficulties	Very rare: neural lesion, perforation of peritoneum, haematoma	Very good analgesia preoperative application possible; blind puncture requires experience, low failure rate
Atraumatic intraoperative instillation of bupivacaine			
Bupivacaine 0.25–0.5%: 0.1–0.5 ml kg^{-1} bw	None known as of yet	None known as of yet	Postoperative analgesia very good; reduction of intraoperative anaesthetic agents

the recommended dosage is observed[5,9,14]. Following release from hospital 4–6 h after surgery, the parents can maintain postoperative analgesia easily using acetaminophen. As a direct postoperative analgesic, however, our study showed acetaminophen to be significantly less effective than bupivacaine in both the herniorrhaphy ($P < 0.05$) and even more obviously in the orchiopexy group ($P < 0.001$).

The intraoperative instillation of bupivacaine is technically simple, and side effects have not been observed as long as the recommended dosages are observed. Some authors[8,11] consider it to be equally effective to, for example, nerve blocks. The proven anti-inflammatory qualities of bupivacaine represent a further advantage of its use[13].

Table 2 shows a summary of the possible forms of postoperative pain control as well as of their side effects and possible complications. Opiates possess good analgesic effects[12], however, their possible side effects such as sedation, nausea, vomiting or even respiratory depression necessitating longer postoperative monitoring make them inappropriate for ambulatory paediatric surgery. Caudal anaesthesia and nerve blocks[1,4,7,8,10] are as effective as the atraumatic intraoperative instillation of bupivacaine, yet they require specific experience, are more time-consuming and not without side effects and complications. After more than 2500 intraoperative instillations of bupivacaine so far in infants and children up to the age of 14 yr, we have observed good analgesia with no side effects or complications. Local intraoperative instillation of bupivacaine into the wound bed is an uncomplicated, easily applied, reliable method of postoperative pain control without side effects that can be used in herniorrhaphy and orchiopexy.

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Ambulatory Surgery, Vol. 3, No. 2, pp. 83–86, 1995
Elsevier Science Ltd
Printed in Great Britain

0966-6532(95)00011-9

Complications following paediatric ambulatory surgery

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The overnight admission rate following paediatric ambulatory surgery, reasons for such admission and post-hospitalization complications reported by parents during 1988–91 (n = 15 245) were compared to previously reported data for patients undergoing ambulatory surgery during 1983–6 (n = 10 000) in the same institution. The overnight admission rate decreased from 0.9 to 0.3%. Vomiting, complicated surgery and croup were the most common reasons for overnight admission in both series, accounting for nearly 60% of admissions. We were able to contact 10 319 (67.7%) parents on the day following surgery. Of these, 59.9% reported a complication or discomfort following discharge from the ambulatory unit. Vomiting continues to be the leading cause of postoperative morbidity.

Key words: Anaesthesia, paediatric, outpatient; anaesthesia, complications

Introduction

Ambulatory surgery is one of the fastest-growing and rapidly changing segments in our healthcare system[1]. Cost containment is a major reason for this phenomenon; health organizations are reluctant to pay for inpatient surgery and require many complicated surgeries be performed as ambulatory procedures. Among these are tonsillectomy, laparoscopy and bronchoscopy. Moreover, many patients who previously were considered too sick or otherwise inappropriate for ambulatory surgery (e.g. ASA III), now routinely undergo ambulatory surgery. The question is: Is the practice of performing more complex surgeries on sicker patients on an ambulatory basis safe? Are we taking more risks than warranted just to comply with payers' requirements? One way to answer this question is to analyse and compare rates and types of complications. While anaesthetists are now asked to provide care to sicker patients undergoing more complex procedures, their task is facilitated by many new agents and equipment. Many new shorter-acting drugs such as propofol, midazolam, mivacurium, atracurium and vecuronium are now available for use and ambulatory surgical patients may have benefited the most from their short duration of action. New monitoring techniques such as breath-by-breath analysis of respiratory gases provide opportunities for closer patient monitoring. New equipment such as the laryngeal mask airway (LMA) has changed routine airway management at many institutions.

The purpose of this study was to detect changes and trends in postoperative complications following paediatric ambulatory surgery. We analysed present postoperative complications and compared them with our previously reported data[2] to detect changes and trends.

Methods

The Children's National Medical Center (CNMC) provides primary to tertiary care to children from the Washington DC metropolitan area. The inpatient and ambulatory operating rooms are integrated. The ambulatory recovery unit, known as the Short Stay Recovery Unit (SSRU), is open from 7.00 a.m. to 11.00 p.m. Patients requiring medical, surgical, or nursing care after 11.00 p.m. are admitted to the hospital.

Selection criteria

ASA physical status I or II patients are accepted for ambulatory surgery. They are screened through a telephone questionnaire. Anaesthetists are consulted before scheduling ASA III or IV patients. Otherwise healthy ex-premature infants of more than 46 weeks gestational age are accepted for ambulatory surgery. Full-term infants have to be at least 2 weeks old before an ambulatory surgical procedure. A list of acceptable ambulatory surgical procedures is revised periodically and circulated amongst surgeons.

Accepted: 20 April 1995
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Preanaesthetic screening

Patients scheduled for ambulatory surgery undergo a multi-stage screening process. First, a detailed medical history is obtained via a 'phone call made under the supervision of a paediatric nurse practitioner 3–7 days prior to the scheduled date of surgery. If pre-existing medical problems are discovered, the director of ambulatory anaesthesia is notified. Appropriateness of ambulatory surgery is reviewed and a complete evaluation by an appropriate consultant is sought.

A registered nurse makes a second 'phone call to the child's home on the evening prior to surgery. Patients are screened for acute illnesses such as diarrhoea, upper respiratory infection (URI) and exposure to infectious diseases. On the day of surgery, a paediatric nurse practitioner uses set protocols to admit patients. If the patient has acute problems such as URI or fever, or has violated NPO guidelines, staff anaesthetists are consulted prior to initiating the admitting process.

The last step in the preanaesthetic screening is the evaluation by the anaesthetist. This is performed after completion of laboratory testing and before induction of anaesthesia.

Anaesthetic techniques

Preanaesthetic sedation is infrequently used. Anaesthesia is usually induced by inhalational agents. If the child does not accept the mask, intravenous induction with barbiturates or propofol is performed. If the child does not have visible venous access, intramuscular ketamine is used[3].

Propofol and/or metoclopramide are generally administered intraoperatively to patients undergoing strabismus surgery to reduce the incidence of postoperative vomiting[4,5]. Regional blocks are frequently used to decrease anaesthetic requirements and provide postoperative pain relief. Caudal block, ilioinguinal block and instillation of local anaesthetics in the wound are the most frequently used regional techniques.

Discharge criteria

Modified Aldrete discharge criteria are used to discharge patients from the postanaesthesia care unit (PACU)[6]. Patients are then transferred to the SSRU for further observation. They are discharged home when they are alert and oriented, have stable vital signs, can walk with minimal assistance (if appropriate for age) and have minimal nausea and vomiting. Patients whose tracheas were intubated are observed for a minimum of 3 h following extubation; however, the waiting period may be modified by an anaesthetist after evaluating the patient.

Data collection

Information about patients who required overnight hospitalization was acquired while the child was still in the SSRU. Information on patients who were discharged home from the SSRU was collected by a SSRU nurse who telephoned the parents the day after surgery. Questions about vomiting, fever, sleepiness and sore throat as well as headache, bad dreams and upset stomach were directly asked. The questions related to the latter group of symptoms were not asked during the 1983–6 study period. The overnight admission rate, reasons for admission and post-hospitalization complications reported by parents during 1988–91 were compared with previously reported data for 1983–6[2].

Results

A total of 15 245 patients were admitted to the SSRU during the 1988–91 period. The distribution of patients by age and ASA physical status is shown in Tables 1 and 2, respectively. The distribution according to surgical service is listed in Table 3.

There was no mortality within 24 h following surgery. Forty-five of 15 245 (0.3%) patients were admitted overnight to the hospital. The reported admission rate for 1983–6 was 0.9%[2]. Reasons for admission for both periods are listed in Table 4. Vomiting, complicated surgery and croup were the most common reasons for overnight admission in both series, accounting for nearly 60% of admissions.

Table 1. Age of patients undergoing ambulatory surgery 1988–91 (n = 15 245)

Age	*% of patients*
0–6 months	8.2
7 months–2 yr	26.6
25 months–5 yr	37.4
6–12 yr	19.1
>12 yr	8.7

Table 2. ASA physical status of patients undergoing ambulatory surgery 1988–91 (n = 15 245)

ASA physical status	*%*
I	73.73
II	22.94
III	3.30
IV	0.03

Table 3. Distribution of ambulatory patients according to surgical service 1988–91 (n = 15 245)

Surgical service	*%*
Otorhinolaryngology (ENT)	36.4
General surgery	24.8
Ophthalmology	14.3
Urology	11.1
Plastic/reconstructive surgery	3.0
Dental	3.7
Orthopaedics	3.9
Haematology/oncology	0.2
Gastroenterology	0.9
Other	1.7

Table 4. Reasons for overnight admission of ambulatory patients

	1983–6 (%) (n = 10 000)		*1988–91 (%) (n = 15 245)*	
Number of patients admitted overnight	90	(0.9)	45	(0.3)
Reasons				
Protracted vomiting	30	(33)	17	(39)
Complicated surgery	15	(17)	4	(13)
Croup	8	(9)	5	(11)
Parental request	6	(7)	2	(4)
Fever	6	(7)	0	(0)
Bleeding	3	(3)	4	(9)
Sleepiness	2	(2)	2	(4)
Pain	–		3	(7)
Respiratory monitoring (DLB)	–		2	(4)
Bleeding and emesis	–		1	
Vomiting and drowsiness	–		1	
Aspiration	–		1	
Asthma	–		1	
Post-trismus	–		1	
Chest congestion	–		1	
Other	20	(22)	0	

Table 5. Post-hospitalization complications reported by parents

	1983–6 (%)		*1988–91 (%)*	
No. of surgeries	10 000		15 245	
No. of parents contacted	4 988		10 319	
Vomiting (frequency)				
1–2 times	359	(7.2)	796	(7.7)
3–4 times	64	(1.2)	143	(1.4)
>4 times	24	(0.5)	128	(1.2)
Vomiting (total)	447	(8.9)	1067	(10.3)
Sleepiness	297	(5.9)	2365	(22.9)
Cough	324	(6.5)	427	(4.1)
Sore throat/hoarseness	425	(8.5)	427	(4.1)
Fever	235	(4.7)	333	(3.3)
Loss of appetite	–		1156	(11.2)
Muscle pain	–		100	(1.0)
Bad dreams	–		27	(0.3)
Upset stomach	–		138	(1.3)
Headache	–		83	(0.8)
Dizziness	–		62	(0.6)
Total	1728	(34.5)	6182	(59.9)

We were able to contact 10 319 (67.7%) parents in the latter study group on the day following surgery. Of these, 59.9% of parents reported a complication or discomfort following discharge from the ambulatory unit. Approximately 50% of parents in the 1983–6 group were contacted; the rate of discomfort was 34.5%. The results are compared in Table 5.

The following is a detailed narration of the disease and surgical procedures of the five ASA physical status IV patients who underwent ambulatory surgery.

Patient 1. Five-year-old child with Holt-Oram syndrome and tetralogy of Fallot underwent bilateral myringotomy and insertion of ear tubes.

Patient 2. Three-year-old ex-premie with Vater syndrome, sinus inversus, Kartozemian syndrome, bronchopulmonary dysplasia and asthma underwent tracheal biopsy, myringotomy and insertion of ear tubes.

Patient 3. A broviac catheter was inserted in a 3-year-old debilitated child with AIDS.

Patient 4. Seventeen-year-old patient with HIV, herpes and upper respiratory infection (URI) had extraction of infected tooth.

Patient 5. Four-year-old child with Tay-Sachs disease, seizures, chronic pneumonia, progressive neurological dysfunction and paralysis had his gastrostomy (PEG) removed.

Discussion

Ambulatory surgery is no longer reserved for ASA physical status I or II patients. Increasing numbers of

ASA III and even ASA IV patients are scheduled for ambulatory surgery. Moreover, duration of surgery is infrequently a consideration for outpatient care. Procedures lasting 4–6 h are commonly performed on an ambulatory basis. Procedures such as tonsillectomy and bronchoscopy, which have traditionally been done as inpatient procedures are now routine outpatient procedures.

Since patients are sicker and their surgical procedures more complex, the concern would be an increased complication rate. Although life-threatening complications following ambulatory anaesthesia in children are rare, minor problems and discomfort are common[2]. Perioperative problems can be of such a nature and severity that overnight admission following surgery is occasionally required. Our findings, based on comparison of data from 1983–6 vs. 1988–91, indicate that the rate of admission from the SSRU is now one-third of the previously reported rate.

Vomiting is still the most common reason for admission; however, the absolute number of patients admitted because of vomiting has decreased tremendously. During 1983–6, 30 of 10 000 patients (0.3%) were admitted because of vomiting, whereas during 1988–91 only 17 of 15 245 patients (0.1%) were admitted. Factors associated with an increased incidence of vomiting are pain, narcotic administration, early ambulation, history of motion sickness, early oral intake and certain surgical procedures such as strabismus repair, herniorrhaphy, tonsillectomy and orchidopexy. The decrease in the incidence of vomiting may be the result of a combination of factors, such as better control of postoperative pain through regional techniques, increased prophylactic use of metoclopramide, use of propofol for anaesthesia induction and maintenance, late rather than early oral intake and less aggressive efforts to ambulate patients. A further decrease in the incidence of vomiting will occur as our understanding of the mechanism of vomiting increases and through use of future drugs with better antiemetic properties.

A concurrent data collection system has allowed us to analyse the cause of each overnight admission in the present series. Intraoperative anaesthetic and surgical complications such as aspiration, post-trismus and complex surgical procedures, previously categorized as 'others', have been individualized. As a result, the admission rate from intraoperative complications appears to have increased.

All patients who were perceived to require postoperative pain management or respiratory monitoring, even for a short period, were formerly admitted to the hospital. An 'observe and decide' approach is now taken. As we continue to perform increasingly complex procedures on sicker patients on an ambulatory basis, it is expected that this trend will continue.

The absolute increase in the number of reported post-hospitalization complications is clearly due to better data collection and more direct questioning. Between 1983 and 1986, direct questions concerned only vomiting, sleepiness, cough, fever and sore throat. Parents voluntarily offered information about other symptoms such as loss of appetite, muscle pain, bad dreams, upset stomach, headache and dizziness. During the 1988–91 series, we included the latter group of symptoms in our direct questioning. As a result, nearly 60% of parents interviewed in the latter period reported post-discharge complication/discomfort, in contrast to the previously reported figure of 34.5%. The increase in reported incidence of sleepiness from a previously reported 5.9–22.9%, may be due to the change in the phrasing of the question. Parents were previously asked about 'unusual sleepiness' whereas now they are asked if the child has been sleeping 'extra hours'. This emphasizes the importance of asking direct questions and phrasing them appropriately.

In conclusion, in spite of more complicated surgeries performed on sicker patients, the overnight hospitalization rate for ambulatory surgical patients has decreased. This may be a result of various factors such as the experience of the nursing and medical staff, new anaesthetic agents, careful screening of patients, refined surgical techniques and better postoperative care. We expect a further decline in admissions due to vomiting, pain and drowsiness, but may see an increase in admissions due to surgical/anaesthetic complications and for postoperative cardiorespiratory monitoring.

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BUTTERWORTH HEINEMANN

Ambulatory Surgery, Vol. 3, No. 2, pp. 87–89, 1995

0966-6532/95 $10.00 + 0.00

0966-6532(95)00006-2

Ambulatory surgery for hydrocele: a review of 200 cases

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In a prospective study, 200 cases of hydrocele of tunica vaginalis testis were treated by ambulatory surgery. Lord's technique was performed under local anaesthesia. A modified simple scrotal dressing was used to facilitate ambulation. In one case (0.5%), haematoma was reported. There was no wound infection, though in three cases (1.5%) there was recurrence. Patients tolerated the procedure well and ambulation was excellent in all cases. On the grounds of safety and cost effectiveness, most hydrocele repair procedures should be performed on an ambulatory basis.

Key words: Ambulatory surgery, tunica vaginalis, hydrocele

Introduction

In today's world, where time is valuable, all patients demand a speedy recovery from their ailments with minimal pain and discomfort. To keep pace with this and cope up with our patients' demands, while at the same time not compromising on patient care, we started to undertake ambulatory hydrocele surgery.

Performing surgery on patients on an outpatient basis is not a new concept. However, the rediscovery, refinement and extension of ambulatory surgery has come about only in the last two decades.

Ambulatory surgery should be performed for well selected surgical problems which can be managed on an elective basis. The surgical procedure should not last long, with a maximal duration of 1 h and the surgical technique used should involve minimal dissection, thereby minimizing intraoperative haemorrhage and postoperative tissue oedema. These are usually responsible for postoperative pain and discomfort, rendering the patient non-ambulatory and bed-ridden.

It has been routine for hydrocele surgery to involve bulky scrotal dressings and postoperative hospitalization for a minimum period of 72 h for early detection of postoperative scrotal oedema and/or haematoma.

In order to assess whether hydrocele surgery could be performed on an ambulatory basis we undertook a prospective study of 200 cases, performed in our outpatient operating theatre with a postoperative observation period of 2 h[1]. Lord's repair[2] was performed under local anaesthesia involving spermatic cord block. We have found the procedure to be safe, simple, cost effective and highly acceptable to the patients. We also used a modified simple and slim elastic compression dressing, which was effective in providing support and assisted ambulation.

Accepted: 13 April 1995
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Patients and methods

Two hundred patients between the ages of 16 and 68 yr were selected. The criteria for selection were acceptance of local anaesthesia for the procedure, absence of any concurrent untreated medical illness (especially diabetes), absence of local infection, presence of a translucent hydrocele indicating clear fluid with a thin pliable sac and absence of any co-existing pathology of the inguinoscrotal region, such as epididymo-orchitis, hernia or varicocele.

Laboratory investigations included a complete haemogram to rule out anaemia and eosinophilia (filariasis being one of the common causes for hydrocele in our country). Routine urine analysis was also performed to exclude urinary tract infection and diabetes. In the case of eosinophilia, empirical treatment with diethyl carbamazine for a period of 3 weeks was given before surgery. If urinary tract infection was present, it was treated with suitable antibiotics as per urine culture report before surgery.

Surgical procedure

The patients were asked to fast for 12 h preoperatively. Written, valid consent for the procedure was taken and the scrotum shaved. Premedication with intramuscular

atropine 0.6 mg was given. Before taking patients into the operating theatre they were asked to evacuate their bladders.

After cleaning and draping 5 ml of 2% lignocaine was injected into the cord at the root of the scrotum and another 5 ml was injected into the layers of scrotum at the chosen site of incision after grasping the scrotum and tensing the hydrocele.

An incision of 5 cm in length was made parallel to the median raphe. The incision was deepened in layers to the tunica vaginalis parietalis. The sac was opened in the same line as the incision. No plane of cleavage was created between the layers of the scrotum and haemostasis at the site of incision was obtained using fine haemostats. No cautery was used to avoid the risk of postoperative oedema. On opening the sac, hydrocele fluid was drained and the testis was delivered. Plicating stitches were taken on the inner aspect of the tunica vaginalis parietalis to draw it up into a cuff around the testis. Five to six stitches were usually required. The wound was irrigated with 1% povidone-iodine and the testis was repositioned back into the scrotum. The wound was closed in two layers, dartos muscle layer with chromic catgut and skin with black silk. No drain was used.

Benzoin tincture was applied over the scrotum, and on the lower abdominal wall over an area 5 cm lateral to the symphysis pubis on either side. A 15 cm length of Elastoplast (Ethicon, Johnson and Johnson, India) was divided longitudinally for two-thirds of its length. After protecting the incision site with a gauze piece, the broad uncut portion of the adhesive plaster was applied to the scrotum ensuring that the cut edge was at the base of the penis. The scrotum was then pulled over the pubic symphysis and the cut portions of the elastoplast were stretched and applied to the lower abdominal wall. Another 15 cm length of elastoplast was divided longitudinally along its entire length and each piece was applied laterally to cover the scrotum and give additional support. During the application of benzoin tincture as well as the adhesive plaster, care was taken to avoid the inguinal ligament and the medial aspect of the thigh, to prevent discomfort during ambulation.

After 2 h of postoperative observation the patients were discharged on oral analgesics for 3 days. One dose of antibiotic was given intramuscularly on a prophylactic basis. Patients were asked to report on the next day to the outpatient department for examination. If no pain or tenderness was reported and the wound was devoid of soakage, which was usually the case, it was left undisturbed and the patient was advised to return for follow-up after 7 days for removal of sutures.

Results

All patients tolerated the procedure well. The mean duration of surgery was 25 min with a maximum of 45 min. There were no anaesthesia-related complications. No patients complained of pain either intraoperatively or postoperatively. All patients were subjected to Lord's operation except one patient, whose hydrocele had a positive transillumination test on preoperative clinical assessment but intraoperatively was found to have a thick, calcified and rigid sac. He was treated by subtotal excision of sac and scrotal drainage. He also tolerated the procedure well and was comfortable and ambulatory in the postoperative phase.

In one patient (0.5%), scrotal haematoma was detected on the first postoperative visit when he attended for local examination of the wound. He had severe pain and swelling of the scrotum and was admitted. His scrotum was evacuated and packed. The pack was removed after 24 h and the wound was re-sutured. The patient subsequently made a full recovery. There was no incidence of wound infection in the entire series. No patient complained of any postoperative or dressing-related discomfort. All were ambulant and led a normal active life in the postoperative period.

Over a follow-up period ranging from 6 months to 3 yr three patients have reported back with recurrence. These three cases belonged to the initial series of 75 cases when absorbable 3(0) chromic catgut (Ethicon) was used for plicating. Subsequently we used non-absorbable 3(0) mersilk (Ethicon) in the rest of the 125 cases. Since then we have not encountered any recurrence.

Discussion

Before hospitals evolved as important institutions in our society ambulatory surgery was the oldest known form of surgery. In recent decades most surgical procedures have been performed in a hospital setting. According to the American Hospital Association[3], many minor surgical procedures do not require hospitalization. During the 20th century there have been repeated attempts to re-popularize and extend the advantages of ambulatory surgery. This method of providing surgical care is of advantage to patients, surgeons and providers of health care. As far as the patient is concerned, as long as there are no increased risks, a day case procedure is convenient since there is minimal alteration to his life-style, decreased anxiety, early resumption of work, along with reduced cost. From the surgeons point of view, there is a decreased incidence of nosocomial infections as there is less congestion in the wards. His attention can be focused on the critical patients since there is less ward work due to fewer admissions. The hospitals benefit by increased use of facilities and reduction in the costs involved.

Safety of the patient does not involve a choice between inpatient and outpatient procedures. Safety is an attitude of mind, and when good practice is followed in selection of patients and techniques by the surgeon, there is no reason to expect more complications in an outpatient setting than with hospitalization[4].

Scrotal haematoma is a curse in hydrocele surgery,

the loose tissue of the scrotum giving rise to oedema and haematoma postoperatively if haemostasis is not adequate. It is not uncommon to end up with a scrotum larger than its original size. It is for this reason that many surgeons have been reluctant to discharge patients at an early stage after hydrocele surgery. The average duration of hospitalization in the absence of complications has therefore been between 2 and 6 days[5, 6].

Ambulatory surgery for hydrocele in a general hospital such as ours reduced the cost by one third compared to inpatient surgery (Rs. 50 vs. Rs. 150).

Hospitals must therefore plan and provide outpatient surgical facilities so that appropriate surgeries can be performed on an outpatient basis, enabling patients to be ambulant in the postoperative phase, reducing the cost to the patient, the hospital and the community and assuring optimal use of inpatient beds.

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BUTTERWORTH HEINEMANN

Ambulatory Surgery, Vol. 3, No. 2, pp. 91–96 1995

0966-6532/95 $10.00 + 0.00

0966-6532(95)00005-4

Measurement of ankle cuff discomfort in unsedated patients undergoing day case foot surgery

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Twelve patients undergoing foot surgery were randomized to receive a common peroneal block prior to surgery and were compared with a control group receiving a standard ankle block used in the department for foot surgery. The common peroneal block provided no significant benefit in achieving greater tourniquet comfort. Patients exposed to ankle cuffs are more likely to experience discomfort when applied for periods greater than 45 min at pressures of 250 mmHg and above. Discomfort appeared more commonly related to the posterior tibial area.

Key words: Foot surgery, tourniquet, regional anaesthesia, peroneal nerve infiltrations, podiatry

Introduction

Adequate haemostasis using automatic, regulated pneumatic tourniquet operated cuffs during foot surgery has been well documented[8]. The use of a cuff at the ankle level, as opposed to the thigh, is commonly used in unsedated patients undergoing regional anaesthesia; primarily because less discomfort is experienced. The problem with thigh placement may be associated with higher cuff pressures needed to control haemostasis. Lichtenfeld has disputed previous views suggested by Klenerman concerning potential nerve damage from compression[8]. Trauma at the site of the ankle, where there is less muscle bulk and fat to cushion the bone and nerves against pneumatic compression, is thought to make the technique less safe.

An Esmarch tourniquet can be used to exsanguinate the limb effectively before inflating the cuff. On its own, the Esmarch tourniquet has been found to be perfectly safe and is used as an alternative to the pneumatic cuff. Pressures of 250 mmHg have been measured and can be safely used for up to 2 h[7]. Pressures can be increased however by placing more wraps of the elastic material around the ankle. While the pressure created around the ankle was shown to have no side effects, comfort was not measured or discussed.

Foot surgery can be performed using four main systems of anaesthesia: general, central (spinal or epidural), intravenous (Bier block) and peripheral regional blocks. Regional (placed at the knee, ankle or foot level) anaesthesia appears to have no recorded systemic problems compared to other methods, save injudicious intravascular infiltration. Such anaesthesia is effected by infiltrating small volumes of anaesthetic around specific nerves. The technique is suitable for cases often regarded as a poor anaesthetic risk. The risk of intravascular infusion is unlikely in skilled hands and such procedures can be performed without an attendant anaesthetist. The comfort for the conscious patient is often affected by cuff anxiety. While a general anaesthetic can be offered should discomfort become intolerable[4,8], any extension of maximum cuff times would be precluded by the anaesthetic model as custom and practice prefer optimum cuff times of around 90 min when using any form of anaesthetic. Replacement of cuffs may be carried out after a period of rest, thus extending haemostasis where necessary. In unsedated patients, the author (DT) has found comfort seems to last for a much shorter period on reapplication.

Intravenous anaesthesia, as with general and spinal methods, should only be performed by an anaesthetist. The use of double cuff chambers however can eradicate cuff discomfort around the ankle and are therefore suitable for conscious patients[9]. Comfort is achieved by allowing intravenous anaesthesia to perfuse under the distal chamber before deflating the proximal chamber. The greatest risks from Bier blocks arise from intravascular damage and systemic effects of a large bolus of anaesthetic suddenly entering the central vascular system.

Ankle cuffs are set at 100–150 mmHg above systolic pressures. Binns and Prendergast[1] found that patients became restless and complained of pain when pressures

Accepted: 28 March 1995
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above 210 mmHg were applied around the ankle, the calf or thigh for longer than 30 min. In order to ameliorate cuff discomfort, a new cuff was devised which incorporated an air bag to compress the posterior tibial vessels, allowing pressures of 250 mmHg following exsanguination. This cuff design was tolerated for up to 40 min. While the cuff designed by Binns and Prendergast looks encouraging, little discussion has considered some of the additional problems met with ankle cuffs. Problems include ankle oedema and the need to manage sudden raised systolic pressures and the effects of vascular leakage. Infiltration of anaesthesia around the superficial peroneal nerve around the ankle was thought to supplement cuff comfort[2].

Gurmarnik and Hurwitz[6] observed that a combined saphenous and common peroneal block, performed above the ankle, could ameliorate cuff discomfort. Operation time was extended up to 98 (±7) min in their study of 42 infiltrations. They observed that using traditional regional blocks, ankle tourniquets could be tolerated up to 47 min.

Lichtenfelt[8] identified two patients who, at 45 and 70 min respectively, reported mild pain. One patient, in his study of 76 patients, required a general anaesthetic. Another patient had venous oozing which was overcome by tourniquet release.

Cuff pain is characterized by patients becoming fidgety, raised blood pressure, obvious anxiety and even crying. While these signs and symptoms are highly undesirable, the last part of a procedure can be critical to maintaining good haemostasis. Any technique that can improve comfort, particularly after the empirical band of 45 min is worth investigating.

Most day case foot surgery lasts between 10–90 min with 67% of operations falling into the band 16–30 min[10]. The anaesthetic technique was performed as a regional ankle block or metatarsal block using 1 or 2% prilocaine.

Methods and materials

This paper concerns data from a clinical audit to measure the effectiveness of a common peroneal block to deal with cuff discomfort during surgery. The use of a visual analogue scale (VAS) was used to record discomfort during the course of surgery with a cuff applied superior to the malleoli. Measurements were taken as a line of continuum, patients should not be able to see the scales, marked as no pain to worst pain possible. The advantage of VASs is that they can provide interval measurement, do not require descriptive terms and provide many points to select from[7].

Patients

Patients were randomized for either a common peroneal block (CPB) and placed in group A, or in a control group B. Patients were randomly chosen by their date of birth and males and females were randomly accepted into the project. Those with odd birth years were entered into group A and even years, Group B. Both groups received the standard inferior ankle blocks, suited to the intended surgery (Table 3). Anaesthesia at the inferior ankle level followed either a tibial block or metatarsal ring block with plain anaesthesia.

Measurement

Units taken from the VAS were measured with a 15 cm ruler. Pain was recorded for the time of onset, intolerable discomfort time (IDT) and the maximum discomfort level. The initial level of discomfort was recorded and then the final discomfort level, maximum discomfort level (MDL). The difference between these two points was recorded as the difference in discomfort level (DDL). The sheet was scored with a fine pen. Time was recorded in minutes, CPB effect noted (worked or failed); the IDT was recorded separately and the maximum cuff pressure was recorded. Patients' weight and height were noted together with age.

The term 'discomfort' was adopted as pain is a relative expression. Maximum discomfort was regarded as a point where the patient advised that they were experiencing intolerable discomfort.

Common peroneal block

CPB consisted of 1% plain prilocaine injected inferior and posterior to the head of the fibula at the neck which was usually palpable. The block was given up to 30 min before surgery and usually showed an onset within 5–25 min. A Braun nerve stimulator, Stimuplex, was available where anaesthesia proved to be difficult. The quantity of local anaesthetic consisted of an initial bolus of 5 ml, if this failed a further 2–5 ml was administered.

Surgery

All operative procedures were undertaken on the forefoot (Table 3). Forty-three patient results were collected initially, 28 patients were accepted and placed into group A and group B (Table 1). All patients in the first two groups were unsedated. An effective CPB was considered when either the patient showed sensory loss over the cuff area at the end of surgery or when foot drop was elicited before surgery. Those patients who had a CPB which failed were placed into a further group C and group D, where results were affected by outside factors such as premedication or preoperative oral analgesics.

Ankle cuff

The tourniquet was placed 0.5 cm above the medial malleolus and padded with orthopaedic cast wool (Velband, Johnson & Johnson); the padding extended beyond the cuff for 0.5 cm. Cuff sizes varied according to the system available in one of five theatres used. The same protocol for precuff exsanguination using an Esmarch bandage was adhered to by each of the three

Table 1. Patient data (n = 43)

Sex	*Age*	*MDL*	*DDL*	*Time*	*Pressure*	*wt*	*ht*	*IDT*
Group A – subjects provided with a common peroneal block which was deemed successful								
F	35	16	10	48	220	48.8	1.50	–*
M	51	07	10	41	300	89.1	1.78	–
F	19	77	76	70	205	72.0	–	–
F	55	01	00	–	250	74.8	1.58	–
F	53	64	52	52	243	97.5	1.66	–
F	52	25	22	60	250	74.8	1.66	53
F	–	03	00	35	210	55.3	1.53	–
F	67	04	00	22	260	–	–	–
F	77	89	84	71	260	55.9	1.55	56
F	25	19	00	70	250	–	–	–
F	21	02	00	14	210	52.9	1.59	–
F	52	25	22	60	250	–	–	–
Group B – subjects not exposed to common peroneal block								
F	26	100	102	83	212	70.0	1.68	68
F	40	21	00	49	240	58.5	1.60	–
F	68	02	00	73	290	62.0	1.78	–
M	56	07	03	52	250	78.0	1.75	–
F	50	84	82	68	250	86.5	–	–
F	54	55	00	85	226	61.8	1.53	–
F	36	05	05	44	240	75.1	1.63	–
F	52	04	02	55	250	65.0	1.38	–
F	22	04	02	68	213	–	–	–
F	72	10	00	16	264	–	–	–
F	72	50	50	20	260	54.0	1.58	–
F	40	10	02	41	–	104.0	1.69	–
F	30	51	51	47	240	58.5	1.65	–
F	58	69	22	74	260	61.4	1.50	53
M	56	51	24	83	240	–	–	–
F	58	46	00	44	230	71.5	1.65	–
Group C – subjects who failed to respond to CPB from group A								
F	32	82	80	88	238	69.6	1.58	78
F	78	08	05	35	270	57.6	1.70	–
F	67	07	03	31	250	68.3	1.55	–
F	71	58	54	22	260	62.4	1.55	–
F	71	03	00	49	270	74.8	1.68	–
F	35	75	73	72	250	65.0	1.71	60
F	59	12	08	69	320	71.5	1.64	–
F	69	08	00	107	280	58.5	1.55	–
F	29	28	26	80	230	52.0	1.58	–
Group D – subjects excluded from study (see text)								
M	59	28	23	93	300	68.3	1.56	–
F	42	41	37	27	220	46.8	1.60	–
F	54	16	09	35	240	–	–	35
F	72	10	00	40	260	59.4	1.55	–
F	68	87	55	71	310	73.0	1.56	63
M	69	10	07	28	250	–	–	–

MDL, Maximum discomfort level; DDL, difference in discomfort level (before and at end, before cuff release); IDT, intolerable discomfort level. Groups C/D were included for complete data. *Data not available.

surgeons. The cuff was inflated and maintained at 100 mmHg above systolic pressure, using either a Thackeray, Stille type CO_2 (two independent cuffs) or an air Stille system (single independent cuff). Only single cuffs were used. The patients were monitored, where possible with a Critikon, Dinamap 845XT vital signs monitor, set for 2–4 cycles per hour.

Exclusions in group D

Two patients were excluded because of need for sedation; oral diazepam in one case and intramuscular midazolam in the other. Another patient took nearly one week's worth of non-steroidal anti-inflammatory drugs (NSAIDs) and paracetamol with 30 mg codeine phosphate × 2 without direction prior to surgery, and was excluded.

Results

Patient data was recorded and is shown in Tables 1, 2 and 3.

Difference between groups A and B

Maximum discomfort levels (MDL) and difference in discomfort levels were compared using a Mann-Whitney U test ($P > 0.05$); no significant difference was determined.

Correlation

Total operative cuff time against MDL ($R = -0.13$). Cuff pressure against MDL ($R = 0.41$), both showing no association as seen by the scattergram, representing all the groups (see Figure 1). Height and weight as well as age showed no significant correlation with discomfort levels.

Pain analysis

Intolerable discomfort time (IDT) showed a range between 35–78 min, MDL ranging between 16–100 (mean = 67.9, SD = 30.8). Eight patients (18.6%) recorded intolerable discomfort (95% CI = 7.0–30.2). Absence of pain was further analysed using a 2 × 2 contingency table (χ^2 with Yates correction $\chi^2 = 0.0047$, df = 1). The CPB produced no significant reduction in discomfort.

Difference between group times

Data for groups A–C were separated into patients who were exposed for 45 min ($n = 12$) and those >45 min ($n = 23$); significance was shown, $P < 0.05$ using a Mann-Whitney two tail test.

Discussion

Only eight (18%) female patients (88.4% of the study) recorded intolerable discomfort on their record sheets.

Table 2. Data for 43 patients, groups A–D

	Pressures (mmHg)	*Age (yr)*	*Time (min)*	*MDL (mm)*
Range	205–320	19–78	14–107	1–100
Median	250	54	52	17.5
Missing data	1	1	1	0

Table 3. Forefoot procedures

Osteotomy first ray	14
First MTP implant	3
Keller excisional Arthroplasty	4
Lesser metatarsal	1
Arthrodesis hallux IPJ	1
Lesser toe IPJ	5
Neurectomy	3
Excision tissue	3
Combinational osteotomy	8*
Implant/screw removal	1
Total	43

*Combinational procedures include first ray and at least one other procedure.

One patient showed psychological distress; in her case anxiety appeared to occur in similar environments to the day surgery unit, such as seeing the dentist.

One patient, aged 54, having received midazolam (IM), stated a maximum level of discomfort of 16 on the VAS scale at 35 min, at a blood pressure of 240 mmHg and indicated an intolerable level of discomfort. The majority of patients were able to remain comfortable for more than 16 min. The result recorded above seemed atypical of that expected and was possibly associated with a misunderstanding in recording. Age and blood pressure were not found to correlate with onset of cuff discomfort.

Discomfort from the cuff was thought to stem from anterior shin compression in our own patients. Analgesia in the form of superior anaesthesia (given above the ankle) should ideally ameliorate such discomfort around the site of the cuff. During the course of the study, however, it was soon realized that the site of greatest discomfort lay at the posterior calf, not the anterior aspect of the tibia as previously thought; an area not supplied by the common peroneal or indeed the saphenous nerve.

The clear failure of the CPB technique in achieving 'foot drop' or dorsal anaesthesia on occasions was related to differences in operator technique and the natural difficulty in locating a nerve, reputed to be easy to locate around the head of the fibula.

The use of the VAS system for pain measurement may not be sensitive enough as an 'outcome measure'. Despite the use of the word 'discomfort', instead of 'pain', it was felt that some patients, perhaps more often the older group, had greater difficulty in following the

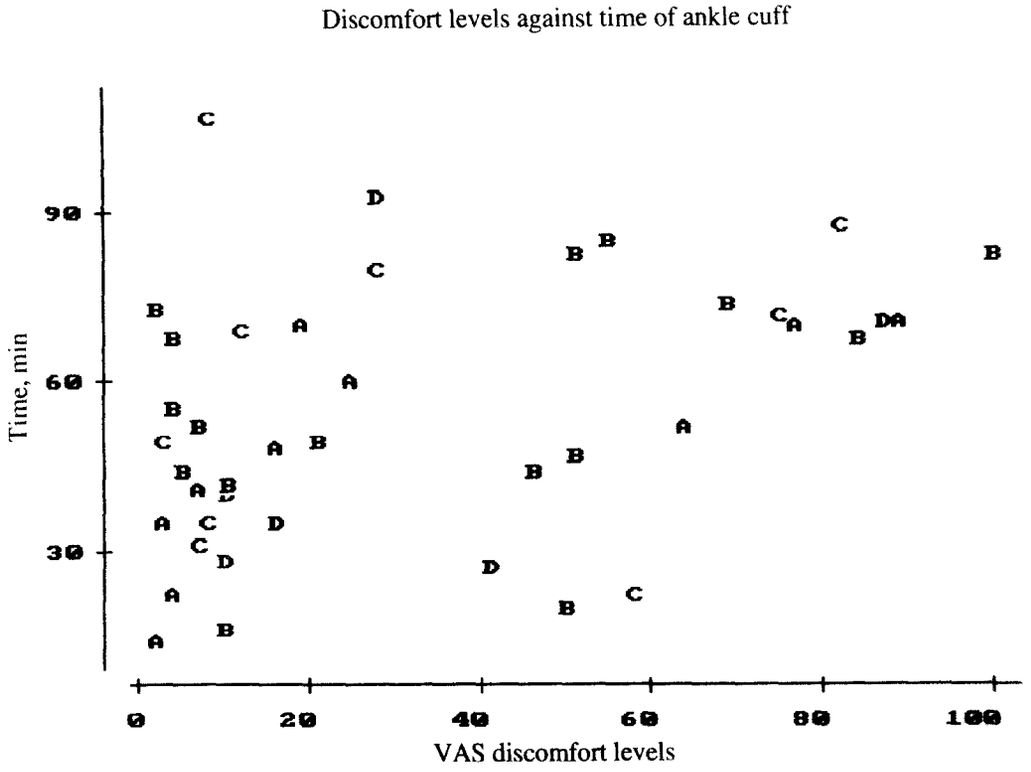

Figure 1 A scattergram was produced showing discomfort levels 0–100 against time. Each group A–D, identified separately in each table, was shown. No correlation was shown on line of best fit.

instructions. At the time of recording data, patients had to be carefully checked not to record levels more than twice. The scale used to measure discomfort was more complex than necessary, having been traced from a plastic VAS measurement tool; this scale should be simplified without double continuous ended lines.

Some cuffs had two and a half wraps as opposed to single wraps; perhaps this should have been recorded except that there appeared to be little association with pressure and pain levels.

Conclusion

Pain will increase after 45 min using an ankle tourniquet ($P < 0.05$). This has implications for planning long duration foot surgery under local anaesthetic regional blocks. As a result of this study, where complex techniques and multiple digital surgery on one foot are required, other factors such as effective postoperative pain control and infection is felt to be better controlled by staging procedures within the time according to the surgeon's skill and capability.

The use of a common peroneal block may well assist anterior shin discomfort but cannot affect the posterior leg. There was no significant difference between the CPB, group A to suggest that the use of the block should be used primarily to ameliorate cuff discomfort. The authors question the accuracy behind the empirical findings associated with the Gurmarnik study[8]. The CPB showed no undesirable postoperative effects when used in the manner described for 13 patients; other authors have warned of a risk from postanaesthetic neuritis[5].

The presumption that a CPB is easy to administer cannot be supported as nine (42.9%) infiltrations failed and a nerve stimulator did not retrieve all such failures. Inexperienced practitioners, unfamiliar with the anatomy may easily have similar results.

Particular scrutiny is required when using the VAS for assessment. In the absence of a quick, cheap and simple system, normalizing patients' responses will remain a problem for clinical research of this nature. Sample size is another problem affecting reliability of results. In this project, sample size was less than desired. Nonetheless, the experience of processing surgical activity is essential for audit and improving quality when delivering this type of care.

This research was undertaken at Manor Hospital, Walsall and Northampton (Nene College) at Northampton General Hospital day surgery units in 1994.

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BUTTERWORTH HEINEMANN

Ambulatory Surgery, Vol. 3, No. 2, pp. 97–99, 1995

0966-6532/95 $10.00 + 0.00

0966-6532(95)00008-9

Ambulatory forefoot day-case surgery

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We report on our early experiences of performing a variety of forefoot procedures under local anaesthetic as outpatient, ambulatory cases. This new approach may represent a considerable cost saving on previous methods as well as improved convenience for patients. Regional anaesthesia using an intermetatarsal block with a dental syringe and silicone coated needle has simplified the anaesthetic technique and is less painful than using standard hospital disposable syringes and needles. All patients were treated within 2 h of the administration of the local anaesthetic. A bloodless field was achieved with a custom-made ankle tourniquet and the use of bipolar diathermy. Postoperative pain control was achieved by the administration of supplementary long acting bupivacaine into the wound and oral proprietary analgesics in the postoperative period.

Key words: Ambulatory, local anaesthetic, surgery, foot, podiatry

Introduction

Recent NHS reforms have encouraged the increased use of outpatient and day-case surgery. Routine forefoot surgery represents a large part of orthopaedic practice and is generally performed under general anaesthesia on an inpatient basis.

This is highlighted in many studies, one of which reported on 10 348 patients treated in a day surgery unit, where only 757 (7%) were orthopaedic cases[1]. Of these orthopaedic cases 0.8% were readmitted with post-operative complications such as vertigo or drowsiness related to general anaesthesia.

The move towards day-case and outpatient surgery is a topical area of debate in the future provision of surgical services in the UK. Targets of as much as 60% for all surgery being performed on a day basis by the year 2002 have been suggested[2]. Much forefoot surgery necessitates hospital admission but we feel there are opportunities for further development of day surgery in this group.

Forefoot surgery has been carried out using regional intravenous anaesthesia[3,4], ankle block[5,6] and midtarsal block[7]. Turbutt[8] reported on 325 procedures carried out in a Foot Day Surgery Unit using local anaesthetic blocks. Considerable interest has been shown by health purchasers in this unit. We have been offering an ambulatory, forefoot, day-case surgery service with the cooperation of a podiatrist and an orthopaedic surgeon. We have found that adequate analgesia can be achieved by the technically easy Mayo Block[9,10] for first metatarsal surgery, and intermetatarsal or digital blocks for the lesser toes.

Methods

When patients are booked for surgery the procedure and anaesthetic technique are explained and consent obtained. Guidelines on the selection of patients suitable for day-case surgery are used when assessing the patients' suitability for this type of service[11,12]. Those patients unsuitable or who decline this method of treatment are booked for routine surgery under general anaesthesia.

On the day of operation patients are asked to wash the foot with antiseptic soap. The local anaesthetic is given after the foot has been prepared with an antiseptic solution. The use of silicone-coated 27-gauge needles used in conjunction with a self-aspirating dental syringe allow for less painful administration of the local anaesthetic.

For first ray surgery confined to the distal half of the metatarsal and toe a Mayo block is given. Two or three 2.2 ml vials 4% prilocaine hydrochloride are used. This block is achieved in two stages. First, the base of the first intermetatarsal space is palpated and the dental needle inserted into the space to block the dorsal intermetatarsal nerves. It is then advanced deeply to block the plantar nerves. It is inclined at 60° to the horizontal to avoid the plantar penetrating branch of the dorsalis pedis artery (*Figure 1*). Second, the needle is inserted

Accepted: 13 April 1995
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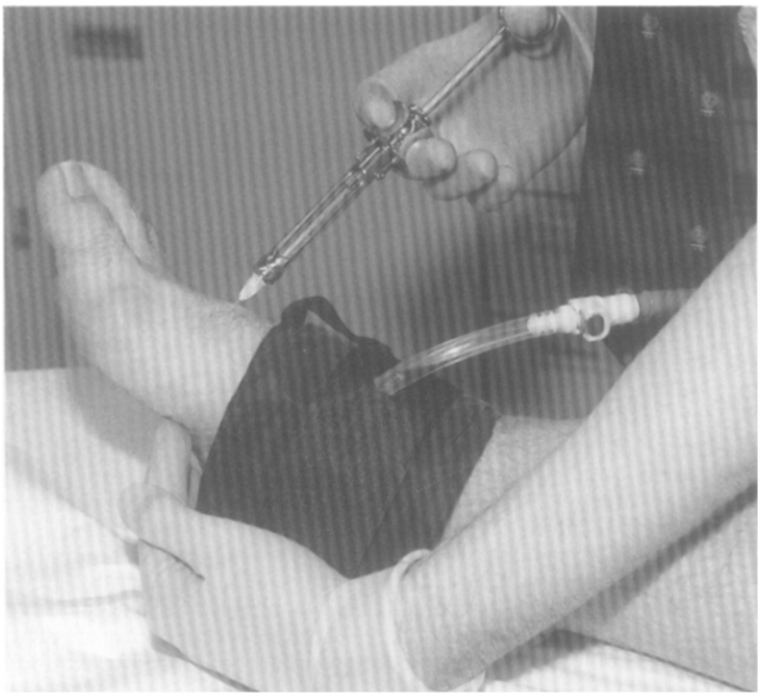

Figure 1 Mayo block being inserted around the baes of the first metatarsal. Tourniquet in position prior to inflation.

and advanced around the medial side of the first metatarsal just below the skin. Injection of anaesthetic here blocks the most medial branch of the medial plantar nerve and terminal fibres of the long saphenous nerve.

By operating on one foot only, dosages are kept well within the recognized maximum safe limits. For lesser toe procedures an intermetatarsal or digital block is employed. Between 15 and 30 min is allowed to ensure adequate analgesia has developed. If necessary local infiltration of anaesthetic can be administered to supplement an inadequate block during surgery. Because the periosteum contains the sensory nerve supply of the overlying skin, bone is adequately blocked and the use of a powered oscillating saw is possible for osteotomies.

Once analgesia has developed, a custom-made tourniquet is applied. This tourniquet is designed to be applied around the ankle and incorporates a cushion to compress the posterior tibial vessels posterior to the medial malleolus. The limb is elevated and exsanguinated with an Esmarch bandage and the tourniquet inflated[13]. We have found that this can be applied painlessly at pressures of 100 mm Hg above systolic for up to 1 h. It has been found to be less painful than a calf or supramaleolar ankle tourniquet.

The foot is prepared as for routine surgery under general anaesthesia. The surgical technique is not altered except for the use of bipolar diathermy to coagulate vessels. In particular, attention is paid to superficial veins along the dorsal aspect of the foot and toes. Wound closure is followed by the administration of between 0.5 ml and 1.0 ml of 0.25% bupivacaine hydrochloride either into or proximal to the wound using a standard disposable syringe. This provides up to 8 h local postoperative pain relief.[14]

After the procedure the patient is kept semi-supine, offered a hot drink and observed for half an hour to ensure arterial return and to assess the degree of postoperative haemorrhage before being allowed home. They are fitted with a postoperative shoe where this is appropriate and instructed to keep the foot elevated and take regular non-demand analgesia such as co-codamol for 24–48 h commencing 6 h after the operation. In this way, severe postoperative pain is avoided[15]. A district nurse visits the patient after 2 days when the dressings are reduced and the wound inspected.

Results

To date, over 50 procedures have been performed in this way. Table 1 shows the range of procedures that have been carried out. There have been no wound infections and no significant complications. One patient required admission 8 h after surgery for pain control.

Discussion

Podiatric surgery is widely practised in North America. In the UK state registered chiropodists or podiatrists are involved in multidisciplinary clinics and within the structure of the changing National Health Service are being referred patients for forefoot surgery.

The cooperation of the podiatrist and orthopaedic surgeon in this situation has been very beneficial. The combination provides an input of complementary professional ideas and techniques which serve to provide the patients with an improved service with short waiting times.

Table 1. Local anaesthetic, ambulatory procedures carried out

First metatarsal
Excision arthroplasty
Distal osteotomy
Metatarsophalangeal fusion
Exostectomy
Bursectomy
Extensor hallucis lengthening
Nail bed ablation
Lesser toes
Hemiphalangectomy
Interphalangeal joint fusion
Amputation
Flexor and extensor tenotomy
Soft tissue
Excision of ganglion
Excision of swelling

Ambulatory foot surgery is well recognized[16]. Addino[17] reported a year's experience of outpatient foot surgery in a podiatric hospital with 79.9% of complication-free cases. This was at the expense of very high levels of patient follow-up.

Infection in this type of outpatient surgery is within acceptable limits. Addino[17] reported a rate of 2.1%, Martin[18] 1.3% and Hugar[19] 1.35%. This compares very favourably with infection rates recorded by Stevens[20] of 5.34% and 2.2% by Miller[21] with inpatient foot surgery. We would however stress the importance of the patient selection procedure as many patients perceived that operation should be carried out under general anaesthetic. Many elderly patients however were enthusiastic about regional anaesthesia rather than a general anaesthetic.

Burn[22] has suggested that day-case surgery could reduce costs by 75% on inpatient levels. Nevertheless, Stott[23] suggested that this fails to take into account the heavier demands that such a service places on ambulance, district nursing and GP services.

We believe that such transfer costs are more than offset to a purchaser by the cost effectiveness of an ambulatory day-case service run by a multidisciplinary team of podiatrist and orthopaedic surgeon. We are continuing to work with this new approach to build up a much larger number of cases. With audit of the service we hope to establish the efficacy of this approach and formalize a cost structure per case.

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