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Source / Izvornik: **International Surgery, 2016, 101, 144 - 152**

Journal article, Published version
Rad u časopisu, Objavljena verzija rada (izdavačev PDF)

https://doi.org/10.9738/INTSURG-D-15-00065.1

Permanent link / Trajna poveznica: https://urn.nsk.hr/urn:nbn:hr:211:217691

Int Surg 2016;**101:**144–152
DOI: 10.9738/INTSURG-D-15-00065.1

Complications, Pain Control, and Patient Recovery After Local Versus General Anesthesia for Open Inguinal Hernia Repair in Adults—Systematic Review and Meta-analysis

Bore Bakota[1], Mario Kopljar[2], Diana Simic[3], Miljenko Franic[4], Mario Staresinic[5], Leonardo Patrlj[6]

[1]*Department of Surgery, General Hospital Karlovac, Karlovac, Croatia*

[2]*Faculty of Medicine, Josip Juraj Strossmayer University of Osijek, Osijek, Croatia*

[3]*Faculty of Organization and Informatics, University of Zagreb, Varazdin, Croatia*

[4]*Department of Orthopaedics, Clinical Hospital Dubrava, Zagreb, Croatia*

[5]*Department of Surgery, University Hospital Merkur, Zagreb, Croatia*

[6]*Department of Surgery, Clinical Hospital Dubrava, Zagreb, Croatia*

The purpose of this systematic review is to provide an "up-to-date" evidence-based guideline and clarify the possible benefits as well as drawbacks of local anesthesia (LA) and general anesthesia (GA) in open inguinal hernia surgery in adults. Study method comprised randomized controlled trials. Primary outcome measures were complications, pain control, and patient recovery. Secondary outcome measures were patient satisfaction and hernia recurrence. A total of 14 randomized controlled trials contributed to the study. A total of 1677 patients were analyzed, with 953 in the LA group and 724 in the GA group. Complications were statistically less frequent in the LA group compared with the GA group [odds ratio (OR), 0.31; 95% confidence interval (95% CI), 0.15, 0.64). Supplemental intraoperative analgesia had a statistical significance in the LA group, with an OR of 28.93 (95% CI, 7.86, 106.47). Postoperative pain was statistically significantly lower in the

Corresponding author: Mario Kopljar, MD, PhD, Faculty of Medicine, Josip Juraj Strossmayer University of Osijek, Nemciceva 2, 10000 Zagreb, Croatia.
Tel.: +385 91 58 27 446; E-mail: mkopljar1972@gmail.com

LA group [standardized eman difference (SMD), –1.06; 95% CI, –1.64, –0.48)]. Length of stay was shorter for patients who underwent operation under LA compared with those receiving GA (OR, –1.21; 95% CI, –2.08, –0.33]). Time to full mobility was shorter in the LA group, without statistical significance (OR, 3.04; 95% CI, 0.19, 47.90), whereas measuring in SMD showed significance in comparison with GA (SMD, –1.74; 95% CI, –2.34, –1.14). Hernia recurrence was not noted. Patient satisfaction was greater in the LA group (SMD, 0.65; 95% CI, 0.15, 1.15). Compared with GA, LA showed superiority in terms of complications, postoperative pain, length of stay, time to full mobility, and patient satisfaction. Therefore, it appears to be a more appropriate anesthetic technique for open inguinal hernia repair in adults.

Key words: Hernia – General anesthesia – Local anesthesia – Complications – Meta-analysis

Despite the fact that open inguinal hernia repair is one of the most common surgical procedures performed with local anesthesia (LA), regional anesthesia (RA), and general anesthesia (GA) worldwide, there is still no general agreement regarding the best anesthetic technique with which it can be performed. Although LA is currently preferred to other types of anesthesia in specialized centers,[1] this practice is not reflected in community hospitals, where most of these procedures are performed.[2] Regarding some risks (referring to those with cardiorespiratory comorbidity), the deployment of up-to-date, short-acting anesthetic drugs enabled GA to be quite suitable for use in day surgery.[3,4] Some complications may also be related to GA, such as postoperative nausea, vomiting, cough, headache, and urinary retention, which prolongs hospital stay and increases the treatment expenses.

On the other hand, the application of LA may be discomforting, and 85% of patients experience intraoperative pain,[2] which directly reflects on patient satisfaction.[5] Although the consensus that refers to the choice of surgical treatment exists, there is no such consensus that refers to the type of anesthetic technique.

Until now, several randomized trials and one meta-analysis tried to address this topic in order to define which of these two most applied and most recommended anesthetic techniques for inguinal hernia repair in adults[4,6] is more suitable for the patient. So far, these attempts have not provided us with a clear answer.

The aim of this meta-analysis is to provide the clinicians an evidence-based guideline related to comparison of LA and GA in open inguinal hernia surgery in adults based on comprehensive research of "up-to-date" literature.

Patients and Methods

The methods we used were adjusted to Cochrane Collaboration standards[7] and defined according to the published protocol.[8] Studies were eligible for inclusion if they were randomized controlled trials (RCTs) comparing LA and GA for open inguinal hernia repair in adults. If the randomization method was not clearly described and the study was declared as being randomized, the study was still included, irrespective of the language reported on. The trials included patients with a clinical diagnosis of inguinal hernia for whom surgical management was estimated as appropriate. We defined complications, pain control (the need for supplemental intraoperative analgesia and postoperative pain), and patient recovery (time to ambulation, length of hospital stay, day surgery stay, time to full mobility, return to work) as primary outcome measures, whereas patient satisfaction and hernia recurrence were defined as secondary outcome measures.

Major complications included respiratory infections and heart failure, circulatory and neurologic disorders that required additional hospital treatment, and other potentially life-threatening visceral and vascular injuries.

Minor complications were defined as the ones whose presence does not require additional hospital treatment (sore throat, headache, nausea/vomiting, urinary retention, etc).

Hematoma included wound hematoma or seroma. Scrotal edema was also included in this study as a separate outcome. Wound infection comprised wound-related infections only.

The need for supplemental intraoperative analgesia refers to the same kind of analgesia/anesthesia initially applied. Conversion is defined as a change of anesthesia type (from local to general). Duration

Table 1 Risk of bias evaluation of each individual trial—review's author assessment[a]

Source, y	Randomization	Allocation	Patients and medical personnel blinding	Outcome assesment blinding	Incomplete outcome data	Selective reporting	Other bias
Godfrey *et al*,[19] 1981	1	1	1	1	3	3	2
Teasdale *et al*,[17] 1982	1	1	1	1	3	3	2
Alsarrage and Godbole,[12] 1990	1	1	1	1	1	3	1
Ofili,[16] 1991	1	1	1	3	1	3	1
Merhav *et al*,[20] 1993	3	3	1	1	1	3	2
Schmitz *et al*,[11] 1997	3	2	1	3	3	3	2
Friemert *et al*,[10] 2000	1	1	1	1	2	3	3
Aasbo *et al*,[13] 2002	3	3	1	1	3	3	3
Gönüllü *et al*,[14] 2002	3	3	1	1	3	3	1
Ozgun *et al*,[21] 2002	3	1	1	1	3	3	3
O'Dwyer *et al*,[15] 2003	3	3	1	1	3	3	3
Srivastava et al,[22] 2007	1	1	1	1	3	3	3
Varshney *et al*,[5] 2008	1	1	1	1	1	3	3
Hosseinpour *et al*,[18] 2013	1	1	1	1	3	3	2

[a]1, high risk; 2, unclear risk; 3, low risk.

of operation was defined as time from first incision to final stitch Postoperative pain is defined as the need for postoperative analgesia due to groin, thigh, or testicular pain at a time point measured after the procedure. Time to ambulation is defined as a patient's time from surgical procedure until the moment when the patient is able to stand and take a series of steps without assistance. Length of hospital stay is measured in time units addressed. Time to full mobility is defined as a patient's time from the surgical procedure to everyday activity performance. Return to work defines the time, measured in days, from surgery to ordinary working activities. Patient satisfaction is a major component used for measuring the quality of health care.

The Cochrane Library, MEDLINE, Embase, CINAHL, SCI-EXPANDED, and SCOPUS, as well as trial registries, conference proceedings, and reference lists, were searched according to the standardized Cochrane search strategy with the appropriate anesthetic technique–specific search terms for open inguinal hernia repair in adults. Trials were identified up to September 2014.

All of the studies were assessed for methodologic quality according to Cochrane Collaboration guidelines as well as for the data gathered; two reviewers performed this independently.

Blinding of the participants from the studies as well as blinding the outcome evaluation for the interventions of focus was not possible. Each piece of data retrieved for the risk of bias calculation was noted together with the sources of these data. The authors who performed this meta-analysis were not blinded to the names of the journals, institutions, authors, or study outcomes. The authors tabulated the risk of bias for each study included (Table 1), together with an assessment of a low, unclear, or high risk of bias for each parameter.

Data were collected into an electronic spreadsheet, and statistical analysis was performed using RevMan 5.3. For dichotomous outcomes, data were analyzed using the Mantel-Haenszel odds ratio (OR) method, whereas for continuous outcomes data the weighted standardized mean difference (SMD) was used. The results were calculated from the patient data of each study and reported using (DerSimonian-Laird) random-effects model. I^2 test was used to test the heterogeneity of the studies. It was planned aside from meta-analysis to calculate the "number needed to treat" (NNT) if a sufficient number of studies showed the same outcome data.[9]

Results

The preliminary enquiry of electronic databases contributed 8567 studies. A further 15 articles were identified because of previously mentioned trials reference reading.

After the duplicate studies were excluded, an analysis of the 7470 articles remaining for their potential relevance revealed 28 trials that could not be eliminated based on title and abstract only. Further analysis enabled us to define 14 studies that matched the criteria for this meta-analysis (Fig. 1).

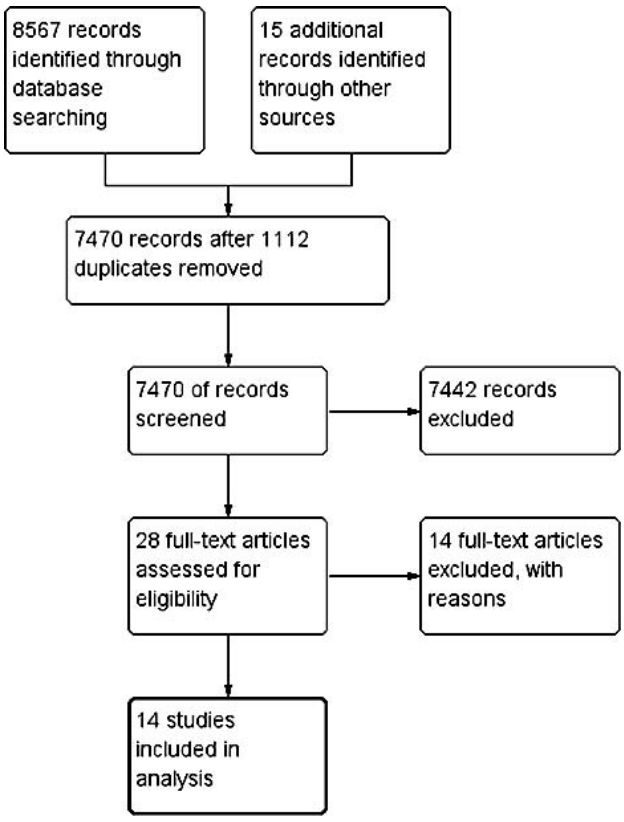

Fig. 1 PRISMA flow chart description of article search.

Characteristics of included studies

A total of 1677 patients from 14 RCTs were included (Friemert *et al*,[10] Schmitz *et al*,[11] Alsarrage and Godbole,[12] Aasbo *et al*,[13] Gönüllü *et al*,[14] O'Dwyer *et al*,[15] Ofili,[16] Teasdale *et al*,[17] Hosseinpour *et al*,[18] Godfrey *et al*,[19] Merhav *et al*,[20] Özgün *et al*,[21] Srivastava *et al*,[22] and Varshney *et al*[5]) were analyzed, with a distribution of 953 in the LA group and 724 in the GA group. Two studies[10,11] were published in German, whereas the other 12 were published in English. Five of the studies compared the outcomes of LA, RA, and GA.[5,19–22] From these studies, we only used the data related to LA and GA. In the remaining 9 studies a parallel 2-arm design was applied.

Characteristics of excluded studies

Fourteen studies were excluded from this meta-analysis for the following reasons: 8 of the studies were not randomized,[23–30] 2 of them were meta-analyses,[2,31] 2 were repeated,[32,33] and in 2 studies two different types of anesthesia were applied at the same time.[34,35]

Risk of bias in included studies

Included studies provided the acceptable data on methodology as well as design. Risk of bias evaluation of each individual trial is presented in Table 1.

All included studies mentioned randomization. The generation of adequate sequence was clearly described in 6 of the studies.[11,13–15,20,21] The method of randomization was not described in 8 studies.[5,10,12,16–19,22] Allocation sequence was adequately concealed in 4 studies,[13–15,20] whereas in 1 study it was not described thoroughly.[11] The report of allocation concealment within the remaining nine studies was not found.

No study reported any blinding of examinees and of examiners, whereas outcome assessment was blinded in 2 studies.[11,16]

Four studies[5,12,16,20] were assessed to have a high risk of bias regarding the incomplete outcome data. One study[5] presented no SDs for the length of stay, and 3 patients in the LA group were actually given GA but were presented in results within the LA group. One study[20] omitted 11 patients from the study postoperatively. Length of stay was also presented without SD in another study as well,[12] whereas one study[16] presented length of surgery with no mention of SD. The authors assessed one study[10] as having an unclear risk of bias due to the fact that it presented the results in medians instead of in mean values with an SD. All of the 14 studies were assessed as a low risk regarding the selective outcome reporting.

Other potential sources of bias were assessed as being low in 6 studies. Three studies[12,14,16] did not present ethics committee approval, patient written consent, or the sources of financing. Two trials were carried out in 1981 (Godfrey *et al*[19]) and in 1982 (Teasdale *et al*[17]), before conflict of interest became a more common issue.[36] Ethics committee approval was not presented by 2 studies,[11,20] and 1 study had no data of written patient consent[18]; these same 3 studies did not present their sources of financing.[11,18,20]

Complications

Mortality was reported in 1 study.[19] One patient in the LA group died. The comparison resulted in favor of the GA group, with no statistical significance [OR, 3.29; 95% confidence interval (95% CI), 0.13, 83.63].

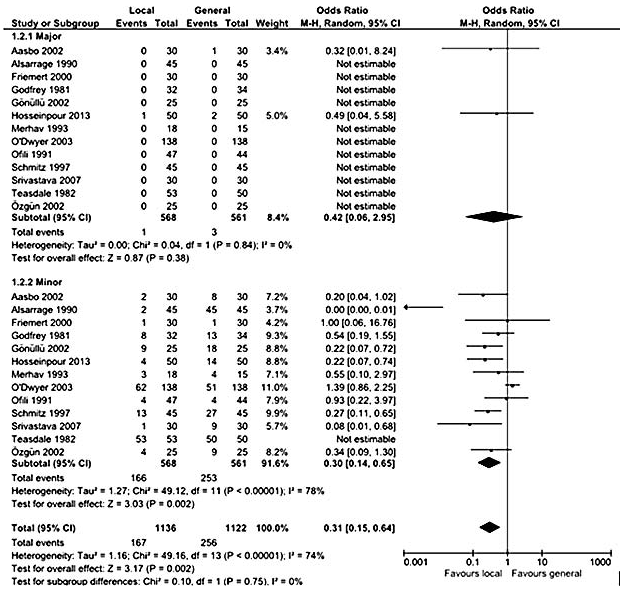

Fig. 2 Occurrence of major and minor complications comparing local and general anesthesia.

Two studies[13,18] reported on 4 examinees with major complications (Fig. 2); 1 patient was operated on under LA and another 3 under GA. The comparison showed no statistical significance (OR, 0.42; 95% CI, 0.06, 2.95). An NNT calculation was performed; in order to prevent 1 major complication, 278.78 examinees would need to undergo LA instead of GA.

A total of 13 trials reported on minor complications: 166 examinees in the LA group and 253 in the GA group, with a statistically significant favor for LA, with an OR of 0.30 (95% CI, 0.14 to 0.65; Fig. 2).

NNT calculation outcome was performed: to prevent 1 minor complication, 6.3 examinees would need to be treated under LA instead of under GA.

Sore throat described in 3 studies[12,17,22] was statistically in favor of LA (5 against 40 occurrences), with an OR of 0.10 (95% CI, 0.02, 0.52). Five studies[11,12,14,17,22] reported an increased number of headaches when GA was applied in comparison with LA (37 versus 7 occurrences), which was calculated as being statistically significant (OR, 0.22; 95% CI, 0.07, 0.67).

Urinary retention reported in 6 studies[12,14,17,18,21,22] occurred in GA more frequently in comparison with LA (28 versus 10) and were statistically beneficial in favor of LA (OR, 0.44; 95% CI, 0.20 to 0.95) as well. Eight studies[11–14,17,18,21,22] report of nausea and vomiting occurrence in GA compared with LA (95 versus 23) in statistical favor of LA, with an OR of 0.13 (95% CI, 0.07, 0.23).

Other minor complications with no statistical significance

Postoperative cough problems described in 2 studies[12,19] occurred, as expected, more often in examinees treated under GA in comparison with LA (18 versus 2 occurrences; OR, 0.14; 95% CI, 0.00, 5.68). Another 2 studies[11,18] reported on minor circulatory problems that occurred more frequently in GA in comparison with LA (7 versus 2 cases; OR, 0.28; 95% CI, 0.06, 1.44). One study[11] reported on one case of dizziness (neurologic complication) in a patient who was treated under LA (OR, 3.07; 95% CI, 0.12, 77.32).

Wound infection reported in 6 studies[12,15,16,18,19,21] occurred more in GA in comparison with LA (13 against 6; OR, 0.48; 95% CI, 0.18, 1.31). On the other hand, more wound hematomas were noticed in examinees who underwent in LA in comparison with GA (38 against 26 cases; OR, 1.44; 95% CI, 0.83, 2.49), reported 9 studies.[10,11,15–19,21,22] Orchiepididymitis (1 versus 0) in one study[17] (OR, 0.31; 95% CI, 0.01 to 7.75) as well as scrotal edema (30 versus 18) in 3 studies[12,15,16] (OR, 0.36; 95% CI, 0.03 to 4.37) occurred more frequently in examinees who underwent GA in comparison with LA.

The need for supplemental intraoperative analgesia was reported in 5 studies,[5,10,13,14,22] and it appeared to have a statistical significance when LA was applied (46 occurrences versus 0 in GA) in favor of GA, with an OR of 28.93 (95% CI, 7.86, 106.47).

One study[17] reported incisional pain with no statistical significance when LA and GA were compared (OR, 1.06; 95% CI, 0.06, 17.44).

Conversions from LA into GA were reported in 3 studies.[5,12,22] Six examinees were converted (1.06%), which represents no statistical significance (OR, 5.22; 95% CI, 0.87, 31.38). An NNT calculation was performed; in order to prevent 1 conversion, 94.67 examinees would have to undergo GA instead of LA.

Length of surgery was reported in 4 RCTs.[12,16,18,21] The application of LA in comparison with GA on the examinees that underwent procedures has resulted in a statistically significant favor for LA, with an SMD of –0.47 (95% CI, –0.81, –0.13).

Postoperative pain was reported in 3 studies[13,14,18] and measured with a visual analogue scale. The result was statistically significant in favor

of LA in comparison with GA (SMD, –1.06; 95% CI, –1.64, –0.48).

The need for postoperative analgesia was reported in 3 studies[15,17,19] as a number of events that required postoperative analgesia. The result was statistically significant in favor of LA in comparison with GA (119 against 140), with an OR of 0.63 (95% CI, 0.41, 0.96). Another study[13] reported on a need for postoperative analgesia in different time frames (6–24 hours, 24–48 hours, and 48 hours to 7 days after procedure), also in statistically significant favor of LA, with an SMD of –0.57 (95% CI, –0.77, –0.38).

One study[22] reported on the duration of postoperative analgesia and found that the SMD was 6.94; 95% CI, 5.56 to 8.32, in statistically significant favor of LA.

Time to ambulate was reported in 2 studies.[17,22] Most of the examinees who could ambulate within the first 6 hours after the procedure were from the LA group (43 against 28) in comparison with the GA group, but with no statistical significance (OR, 3.04; 95% CI, 0.19, 47.90). On the other hand, another study[13] reported on significantly shorter time to ambulate measured in minutes in favor of the LA group, with an SMD of –1.74; 95% CI, –2.34, –1.14.

Time to full mobility was reported in 1 study,[21] and it was statistically significant in favor of LA in comparison with GA, with an SMD of –0.68; 95% CI, –1.26 to –0.10.

Length of stay was also reported in 4 studies.[12,13,18,21] The application of LA in comparison with GA on the examinees who underwent these procedures has resulted in statistically significant favor for LA, with an SMD of –1.21 (95% CI, –2.08, –0.33).

Day surgery stay was reported in 2 studies.[13,17] The comparison resulted in statistically significant favor of LA in comparison with GA (55 versus 62), with an OR of 0.43 (95% CI, 0.18, 0.99).

Time to return to work was reported in 2 studies[19,21] and was shorter in the LA group in comparison with the GA group (SMD, –2.75; 95% CI, –7.44 to 1.95), with no statistical significance.

Patient satisfaction was reported in 3 studies,[5,21,22] with a result that was in favor of GA in comparison with LA (63 against 53; OR, 0.42; 95% CI, 0.01, 21.74), with no statistical significance. Another 2 studies[13,14] reported on patient satisfaction in different time frames (0–24 hours, 24–48 hours, and 48 hours to 7 days after procedure) in statistically significant favor of LA, with an SMD of 0.65; 95% CI, 0.15, 1.15.

Discussion

Comments about studies' quality and results

This review was conducted according to the regulations of the Cochrane Collaboration. The published protocol[8] was applied as a fundament directive to assure the quality of this trial, decrease the possibility of potentially important study dropout, and involve all of the major outcomes within the studies.

Overall, the quality of clinical trials within this meta-analysis in terms of design, reporting, and methodology was acceptable. However, insufficient quality of reporting in some of the included studies resulted in some uncertainties in the risk of bias assessment (Table 1).

The key study-level domains were randomization, allocation, and completeness of outcome data. Just 5 of the studies[11,13–15,20] included demonstrated both adequate sequence generation (randomization) and concealment of the sequence allocation. The data were not completely reported in 4 of the studies.[5,12,16,20]

Blinding of participants was obviously not possible in all of the studies, but because the outcomes assessed in this study are mostly not dependent on the patient's knowledge of the anesthethic procedure, this was regarded as low risk. Blinding of outcome assessment was reported in 2 studies.[11,16] Although it was probably performed in other studies, it was still considered a high risk. Selective reporting risk was evaluated as being low because of the fact that all of the outcomes were reported as stated in their respective methods sections.

Some of the outcomes in studies included in this meta-analysis were heterogenous, and some of the studies had a small sample size, thus decreasing the quality of evidence.

In a summary of risk of bias for each study across domains, 3 studies were considered to have a high risk of bias,[5,12,16] another 8 were considered to have an unclear risk of bias,[10,14,17–22] and 3 were considered to have a low risk of bias.[11,13,15]

The results of the outcomes we obtained provide the evidence that after application of LA in open inguinal hernia repair, patient recovery is faster and persistent pain is reduced. This also stands for observed complications, such as sore throat, headache, urinary retention, nausea, and vomiting, as well as for length of surgery, length of hospital stay, need for postoperative analgesia, and time to ambulation.

Patient satisfaction reported in some studies favors LA. However, not all studies share these results; some of the studies[5] reported continuous pain during the procedure, resulting in 90% patient dissatisfaction when LA was applied. On the other hand, the results from 5 RCTs that are included in this meta-analysis show that 34% of examinees operated on under LA required an additional intraoperative analgesia. All of that refers to the fact that physicians should be adequately trained in applying LA before performing the procedure.[2,4]

Regarding postoperative pain control, the results show that the examinees operated on under LA have more adequate postoperative pain control in comparison with the GA group. Therefore, the necessity of immediate postoperative analgesia application to the patients who undergo GA is a "must" because of the fact that its analgesic effect yields soon after the anesthetic action is gone.

Overall, the outcomes gathered from the studies involved within this meta-analysis have shown that the examinees undergoing LA have a lower incidence of complications in comparison with GA. The outcome analysis in this meta-analysis clearly demonstrates that when adequately applied, LA can provide better intraoperative as well as postoperative pain control in open inguinal hernia repair in adults in comparison with GA.

The results of this comprehensive systematic research could be used as clinical guidelines for the analyzed outcomes. Also, there are various types of different anesthetic techniques observed in other RCTs that were not subject to this meta-analysis. Consequently, the analysis of these interventions may be a topic of future research.

Agreements and disagreements with other studies or reviews

Although LA is being more frequently used as a technique of choice,[1] GA is still the most applied anesthetic technique in most hospitals.[4,37] Because of the fact that every anesthetic technique has its benefits as well as its drawbacks, it is necessary for clinicians to make a proper decision in order to perform the best possible treatment.[38] Even though GA is currently a safe and well-suited method for both inpatient and day surgery procedures, it is not suitable for all patients, particularly regarding complications such as nausea, urinary retention,[39] drowsiness, cognitive effects, and circulatory and respiratory complications.[30] In addition, GA is more likely to affect ventilatory capacity compared with other techniques, resulting in increased incidence of postanesthetic pulmonary complications.[40] Further, GA requires more adequate control of postoperative pain in comparison with LA.[27,30,41] Modern GA techniques resulted in outcomes that followed a GA with more patients experiencing a smooth and fast recovery, with subsequent reduction of hospital stay,[3,35,42] and an increased completion of day case procedures with minimal complications.[43]

Despite these improvements, the use of GA in inguinal hernia repair depends on the requirements of specialized anesthetic personnel with equipment, as well as on postanesthetic care facilities.

Considering the fact that it has the fewest adverse effects for the patient, LA is considered to be a most adequate technique of choice for the patient in open inguinal hernia repairs.[6] LA technique has a short learning curve and requires simple training. It is more economic and requires a shorter time in the operating room. It causes less postoperative pain and requires less analgesic consumption. Several studies showed that LA has fewer adverse effects on patient respiratory function (cough, sore throat) in comparison with GA.[27,28,30] Also, complications such as headache, nausea, and urinary retention are less frequent when LA is applied,[30,39] which makes patient stay shorter, and enables a faster time to ambulation as well as return to work.[27] Patients can mobilize and achieve full mobility with oral liquids and solid food intake much earlier.[30] Furthermore, current guidelines of the European Hernia Society state that local anesthesia is suitable for and should be considered in ASA III and IV patients,[44] and sometimes is the only anesthesia option for elderly and fragile patients.[4] Still, this type of anesthesia may not be easy to apply adequately, infiltration may be painful, and 85% of patients feel intraoperative pain,[2] which could lead to patient dissatisfaction.[5] Also, local anesthesia is hard to apply on patients with morbid obesity and in incarcerated hernia situations.[44] Furthermore, local anesthesia-related complications, such as cardiac arrhythmias secondary to inadvertent intravascular injection[45] and transient femoral nerve block resulting in motor blockade with delayed mobilization,[46] may also occur. Moreover, some authors reported an increased wound infection rate[47] following local infiltration anesthetic inguinal hernia repair. Likewise, there is conflicting evidence on the influence of the choice of anesthesia on the risk of recurrence and reoperation in groin hernias.[32,48] However, a risk of infection rate is diminished when antibiotic prophylaxis is properly applied.[49–51]

Nevertheless, GA remains an option for noncooperative or anxious patients, difficult repairs (reoperation after a mesh repair), and in situations when other anesthetic techniques fail to provide sufficient surgical conditions.[35,44]

Conclusions

A direct comparison of LA and GA has shown significant differences between these two anesthetic techniques.

Apart from the fact that open hernia surgery repair in adults may require an additional intraoperative analgesia, compared with GA, LA showed superiority in terms of complications, postoperative pain, length of stay, time to full mobility, and patient satisfaction. Therefore, it appears to be a more appropriate anesthetic technique for open inguinal hernia repair in adults.

Acknowledgments

Statistical analysis was checked by a statistician.

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