REVIEW ARTICLE

GENERAL ANAESTHESIA VERSUS REGIONAL ANAESTHESIA FOR LUMBAR LAMINECTOMY: A REVIEW OF THE MODERN LITERATURE

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Background: Lumbar spine surgery can be performed using different anaesthetic techniques such as general endotracheal anaesthesia (GA) or spinal-based regional anaesthesia (RA). Few of the studies have been done to compare the outcomes of spinal anaesthesia versus general anaesthesia for lumbar laminectomies as both having some advantages as well as disadvantages but still it is controversial. The objective of current study is to make a comprehensive review of literature for comparing the outcomes of lumbar laminectomy performed under general anaesthesia versus spinal anaesthesia. **Method:** Literature search was performed by using PubMed, Google scholar and bibliography of related articles. To compare groups of general anaesthesia versus spinal anaesthesia, the variables focused were mean heart rate (HR), mean arterial pressure (MAP), blood loss during surgery, duration of surgery, post-operative anaesthesia care unit (PACU) time, post-operative narcotic use/pain scale, post-operative urinary retention, and post-operative nausea/vomiting. **Results:** Data of eleven studies were presented in current article, of these five were randomized controlled trials, three case-controls and four were retrospective cohort studies. 5/8 studies reported that SA group having more hemodynamic stability with postoperative outcomes as compared to GA. Likewise, majority of reviewed studies (7/8) reported better pain control or decreased requirement of analgesics in SA group. Additionally, more than half of the reviewed studies (5/8) reported lower incidence of postoperative nausea and vomiting among patients of SA group. **Conclusion:** The current study concluded that SA has better outcomes than GA in terms of hemodynamic stability and decrease postoperative adverse effects. So special attention should be paid for SA as an alternative to GA for lumbar laminectomy.

Keywords: Spinal Anaesthesia; General Anaesthesia; Lumbar; Laminectomy

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INTRODUCTION

Lumbar laminectomy can be performed under general anaesthesia (GA) as well as spinal anaesthesia (SA) but among these two, the technique is considered to be an excellent one if it has some of the major qualities including rapid onset, easy reversibility, hemodynamic stability during surgery, spontaneous airway maintenance, small duration of recovery and decreased intensity of post-operative symptoms like pain, nausea or vomiting.[1]

Both the anaesthetic techniques having some merits as well as demerits. When comparing general anaesthesia (GA) to regional anaesthesia (RA), RA looks bit superior as it has less risk of pulmonary complications, small quantity of intra operative blood loss, decrease incidence of cardiac complications, little chance of arterial or venous thrombosis and decrease risk of cognitive impairment postoperatively.[2–4] One of the prospective cohort study reported that those elderly patients who were operated under GA, some of them developed dementia as compared to their age-matched controls so suggesting spinal anaesthesia (SA) instead of GA.[5] Lumbar laminectomy and discectomy highlight the need of spinal anaesthesia because of its advantage of prolonged surgeries in prone position with decrease risk of airway compromise, less chance of injury to the brachial plexus and fascial necrosis due to pressure generated by self-positioning of patient.[6,7] Spinal anaesthesia also reduces the duration of hospitalization and provide cost effectiveness. On the other hand, majority of anaesthesiologists prefer GA over SA in microdiscectomy and lumbar laminectomy because of its beneficiary effects in patient's acceptance, extending the duration of surgery and to secure the airway prior placing the patient in prone position.[8]

Few of the studies have been done to compare the outcomes of SA versus GA for lumbar laminectomy as both having some advantages as well as disadvantages but still its controversial that out of these two which one is the ideal anaesthesia technique for laminectomy so the objective of the current study is to make a comprehensive review of

the literature for comparing the outcomes of lumbar laminectomy performed under spinal anaesthesia versus general anaesthesia.

MATERIAL AND METHODS

Literature search was performed by using PubMed, Google scholar and bibliography of related articles. The articles included were those which described the patient who were undergoing either general or regional anaesthesia for laminectomy. The literature search was done by using the multiple medical subject headings (MeSH) terms including "general anaesthesia" versus "spinal anaesthesia" AND "laminectomy" and comparison of anaesthetic techniques for spine surgery. Those articles were excluded which were either not available in English or non-clinical or having spinal procedure other than laminectomy like discectomy, microdiscectomy, hardware placement or any other complex surgical procedure. To compare groups of general anaesthesia versus spinal anaesthesia, the variables focused were mean heart rate (HR), mean arterial pressure (MAP), blood loss during surgery, duration of surgery, post-operative anaesthesia care unit (PACU) time, post-operative narcotic use/pain scale, post-operative urinary retention, and post-operative nausea/vomiting. We didn't include the variables like patient's satisfaction or surgeon's satisfaction because of lack of available data.

RESULTS

The search results showed total of 67 articles but we excluded those articles which didn't match with our outcome variables, or were having any of the confounding factors in their study or missing statistical data or performed spinal procedure other than laminectomy. After this exclusion the remaining articles that were finally reviewed. Out of which two of the studies mentioned the same statistical data[9,10] so they were counted as a single article, so the data of the remaining studies were presented in current article. Overview of study types are mentioned in table-1.

The individual study characters including type of the study, number of the study participants who underwent either general anaesthesia or spinal anaesthesia are presented in table-2.

1. **Hemodynamic Status:**
   The hemodynamic status including mean or change in HR and mean or change in MAP, was reported in eight reviewed studies while out of total studies only one study did not mention the quantity of blood loss as mentioned in table-3. Out of eight studies, the results of five studies reported that SA group having more hemodynamic stability with postoperative outcomes as compared to GA group and the results were statistically significant.[1,9,12,14,18] The two studies showed minimum number of tachycardia during surgery while small number of patients with postoperative hypertension among SA group than GA group with statistically significant *p*-values[8,15] but one of the study manifested non-significant results in which both the groups having equal numbers of patients affected with intraoperative tachycardia and postoperative hypertension[16]. Looking over the quantity of blood loos out of ten studies, half reported non-significant differences as the results were not statistically significant among two groups[8,11,13,14,16] while other half showed decreased blood loss in SA group than the GA one with highly significant *p*-values[1,12,15,17,18].
2. **Duration of Surgery:**
   Duration of surgery depends upon the type of anaesthesia chosen. Out of total eleven studies, ten had reported the time that surgical procedure had taken. Half of the studies manifested that there was significantly decreased surgery time for SA group than GA[9,12,15,17,18] while remaining five had presented statistically non-significant results[1,8,11,13,16] as mentioned in table-3.
3. **PACU Time:**
   As time taken by surgical procedure, likewise PACU time varied between SA and GA groups as reported in table-3. A total of nine studies mentioned PACU time but only four-of-nine had significant results, out of which three reported longer PACU times in SA group than GA group[9,17,18] while one showed vice versa. [15] Among remaining five studies, one had no difference between SA and GA group[16], while two-of-four had reported longer PACU time in GA group as compared to SA group[8,13] and vice versa in left over two studies[1,12].
4. **Post-operative Outcome:**

(i) Analgesic Use/ Pain Score

Out of total eleven studies, eight studied noted post-operative analgesic use or measured pain score by using pain-scale as shown in table-3. Two-of-eight studies reported lower dose of narcotics were needed by the patients of SA group as compared to GA group with highly significant *p*-values.[9,11] The remaining five-of-eight studies mentioned the decreased incidence of analgesic use among SA group patients than that of GA group[1,8,12,13,16] while one study reported higher pain score in GA group than the RA group[15].

(ii) Urinary Retention:

Selection of anaesthesia influences the post-operative complications like urinary retention as mentioned in table-3. Five-of-eleven studies reported the incidence of urinary retention, four

of them mentioned higher rate of incidence among GA group than SA group with significant *p*-values[9,11,15,18] while remaining one study also reported the same results but was non-significant[12].

(iii) Nausea:

The last variable compared among the patients of two groups was the incidence of post-operative nausea or incidence of the use of anti-emetics and was reported by eight-of-eleven studies. Four-of-eight studies reported higher incidence of nausea in GA group as compared to SA group in which three studies had significant *p*-values[9,12,15] while one had non-significant results[8]. Out of remaining four studies, three had mentioned higher incidence of nausea in SA group than GA group but all results were non-significant[1,16,18], while one study reported higher incidence of post-operative use of anti-emetics in GA as compared to SA group with significant *p*-values[13]. (Table-3)

Table-1: Overview of study types

Type of Study	Number of articles reviewed (n=11)
Randomized control trial	5
Case control trial	2
Retrospective cohort	4

Table-2: Individual study data

Study	Type	n (total)	n (GA)	n (SA)
Greenbarg *et al*, 1988[11]	Case-control	80	40	40
Jellish *et al.*, 1996[12]	RCT	122	61	61
Rung *et al.*, 1997[13]	Retrospective	14	7	7
Tetzlaff *et al*., 1998[14]	Retrospective	803	192	611
McLain *et al*., 2004[9] McLain *et al*., 2005[10]	Case-control	400	200	200
Sadrolsadat *et al*., 2009[8]	RCT	100	50	50
Attari *et al.*, 2011[1]	RCT	72	37	35
Khajavi *et al*., 2013[15]	RCT	80	40	40
Kahveci *et al*., 2014[16]	RCT	80	40	40
Agarwal *et al*., 2016[17]	Retrospective	542	178	364
Pierce *et al.*, 2017[18]	Retrospective	544	183	361

Table-3: Comparison of spinal anaesthesia to general anaesthesia

Study	HR or max ΔHR	MAP or max ΔMAP	Blood Loss	Surgery Time	PACU Time	Analgesic Use/ Pain Score	Urinary Retention	Nausea
Greenbarg *et al*., 1988	–	–	GA: 290 SA: 188.3 *p*>0.05	GA: 120.3 SA: 115.2 *p*>0.10	–	GA: 3.2 SA: 1.1 *p*<0.01 (doses)	GA: 50% SA: 10% *p*<0.001	–
Jellish *et al*., 1996	GA> SA at PACU admission *p*<0.05	GA> SA across time *p*<0.05	GA: 221±32 SA: 133±13 *p*<0.05	GA: 81.5±3.6 SA: 67.1±2.8 *p*<0.05	GA: 80.3 (2.8) SA: 85.4 (4.2) *p*>0.05	GA: 80.3% SA: 26.2% *p*<0.05 (incidence)	GA: 22.9% SA: 14.8% *p*>0.05	GA: 25% SA: 5% *p*<0.05
Rung *et al.,* 1997	–	–	GA: 63±52 SA: 45±33 *p*>0.1	GA: 99±57 SA: 96±28 *p*>0.1	GA: 87±29 SA: 48±38 *p*>0.1	GA: 71% SA: 0% *p*<0.05 (incidence)	–	GA: 57% SA: 0% *p*<0.05 (incidence of anti-emetic use)
Tetzlaff *et al.,* 1998	GA: +21.2±11.6 SA: −26.1±4.0 *p*<0.05	GA: +18.9±5.6 SA: −14.2±4.0 *p*<0.05	GA = SA *p*>0.05	–	–	–	–	–
McLain *et al*., 2004; McLain *et al*., 2005	GA: 79±9 SA: 72±7 *p*<0.001	GA: 105±8 SA: 95±9 *p*<0.001	–	GA: 120±30 SA: 105±30 *p*<0.05	GA: 120 SA: 225 *p*<0.001	GA: 1.0 SA: 0.6 *p*<0.01 (doses/h)	GA: 24% SA: 8% *p*<0.001	GA> SA *p*<0.005
Sadrolsadat *et al*., 2009	GA: 26% SA: 6% *p*<0.01 (tachycardia incidence)	GA: 38% SA: 6% *p*<0.001 (HTN incidence)	GA: 438±67 SA: 465±69 *p*>0.05	GA: 94.1±17.9 SA: 94.4±17.3 *p*>0.05	GA: 23.8±7.8 SA: 21.7±8.8 *p*>0.05	GA: 62% SA: 22% *p*<0.001 (incidence)	–	GA: 18% SA: 10% *p*>0.05
Attari *et al*., 2011	GA: +17.5±5.5 SA: −13.2±3.9 *p*<0.05 (HR)	GA: +21.0±6.7 SA: −25.1±4.2 *p*<0.05 (MAP)	GA: 350±35 SA: 210±40 *p*<0.05	GA: 111.0±7.4 SA: 115.0±3.2 *p*>0.05	GA: 50±5.9 SA: 55±6.7 *p*>0.05	GA: 16.2% SA: 0% *p*<0.05 (incidence)	–	GA: 2.7% SA: 5.7% *p*>0.05
Khajavi *et al*., 2013	GA: 80% SA: 30% *p*<0.01 (tachycardia incidence)	GA: 52% SA: 10% *p*<0.001 (HTN incidence)	GA ≥ SA *p*<0.01	GA: 119±5 SA: 121±7 *p*<0.001	GA ≥ SA *p*<0.01	GA: 16±1.5 SA: 6±1.7 *p*<0.001	GA: 57% SA: 5% *p*<0.001	GA: 45% SA: 15% *p*<0.01
Kahveci *et al*., 2014	GA: 10% SA: 10% *p*≥0.05 (tachycardia incidence)	GA: 25% SA: 10% *p*≥0.05 (HTN incidence)	GA: 133.5±37.3 SA: 126.5±40 *p*≥0.05	GA: 72.7±25.3 SA: 70.7±22.2 *p*≥0.05	GA: 20.85±5.2 SA: 19.55±4.6 *p*≥0.05	GA: 30% SA: 7.5% *p*<0.001 (incidence)	–	GA: 10% SA: 15% *p*≥0.05
Agarwal *et al*., 2016	–	–	GA: 180 SA: 65.2 *p*<0.001	GA: 151 SA: 98.3 *p*<0.001	GA: 113 SA: 177 *p*<0.001	–	–	–
Pierce *et al.,* 2017	GA: +79±12.7 SA: 76.6±12.5 *p*<0.05 (HR)	GA: 80.6±5.1 SA: 76.6±12.5 *p*≥0.05 (MAP)	GA: 176.3 SA: 62.1 *p*<0.05	GA: 151.8 SA: 97.4 *p*≤0.05	GA: 116.5 SA: 178 *p*≤0.05	–	GA: 51.9% SA: 11.9% *p*<0.001	GA: 9.8% SA: 12.5% *p*>0.05

Δ; change in, HR; heart rate, MAP; mean arterial pressure, PACU; post-operative anaesthesia care unit, GA; general anaesthesia. SA; spinal anaesthesia, HTN; hypertension

DISCUSSION

SA and GA both are good anaesthetic techniques for laminectomy as multiple studies did comparison but none of them reported superiority of any of the technique in sense of either morbidity or mortality.[19] Many reviewed studies in the current study suggested SA over GA because of post-operative benefits like McLain *et al* did a case-control study reported SA was more effective than GA due to good patient's hemodynamic status and decreased post-operative nausea and pain score.[9,10] Likewise, two randomized controlled trials (RCT) concluded with superiority of RA over GA because of its number of benefits including good maintenance of hemodynamic status throughout the surgery, decreased bleeding during surgery, and decreased requirement of postoperative narcotics.[1,12] Sadrolsadat *et al* did not clearly concluded in his study about the best technique between two for laminectomy but he reported decreased peri-operative incidence of tachycardia, hypertension and post-operative analgesic's requirement in SA group as compared to GA. There was a major confounding factor in his study that was the use of propofol for sedation in SA group but not in GA group[8], this type of confounding is not mentioned by any other study.

The current review favoured the superiority of SA over GA as the reviewed data manifested good control of heart rate and blood pressure, the most probable reason for this hemodynamic stability in SA group is decrease intra-operative stimulation of stress hormones and interleukins, resulting in decrease fluctuation of HR and MAP.[1,20,21] Similarly, decrease intraoperative bleeding in SA is due to vasodilation and resulting hypotension, occurred because of either sympathetic blockade or ventilation maintenance that decreases intrathoracic pressure and less venous distension especially of epidural veins.[22] Although 5 out of 10 studies reported decrease intraoperative bleeding in SA, that might be due to decreased incidence of hypertension during the surgical procedure as compared to GA group.

Likewise, majority of reviewed studies (7/8) in current article reported better pain control or decreased requirement of analgesics in SA group. One of the studies explained the possible reason for this is the sensory blockade that has delay recovery than the recovery of motor system[1] while another study manifested the selective inhibition of afferent nociceptive pathways in SA group[23]. Additionally, more than half of the reviewed studies (5/8) reported lower incidence of postoperative nausea and vomiting in SA group than GA because the GA decreases the gastric emptying resulting in increased incidence of nausea and vomiting but this is not the feature of SA.[24] One of the study manifested that use of N_2O gas in GA might be the reason behind the post-operative nausea and vomiting.[23]

Despite of these all advantages of SA over GA for laminectomy, there are some limitations for using SA including absolute and relative contraindications like spinal stenosis involving multiple spines, history of either seizure or intracranial hypertension or coagulopathies, infection at the point of needle insertion, hypovolemia, myelographic blockade and myelographic arachnoiditis.[1] Beside these factors, choice of anaesthesia depends upon the satisfaction of all including patient, surgeon and anaesthetist.

CONCLUSION

Both spinal and general anaesthesia are good anaesthetic techniques for laminectomy but the current study suggested that SA has better outcomes than GA in terms of hemodynamic stability and decrease postoperative adverse effects. So special attention should be paid for SA as an alternative to GA for laminectomy.

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