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Safety and Feasibility of Segmental Thoracic Spinal Anaesthesia (STSA): A Scoping Review

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Abstract **Review Article**

Spinal anesthesia was previously advised only below the termination of spinal cord in the lumber region to avoid injury to cord. As anatomy of spine and its relation within spinal cord is more understood various case reports and feasibility studies were published in authentic journals describing puncture at thoracic level in certain high-risk patients. Thoracic segmental spinal anesthesia is a neuraxial regional anesthesia technique that can potentially be a suitable alternative to general anesthesia for certain cases particularly in patients who are considered at high risk while under general anesthesia. Practicing a new technology and designing policy decisions based on a single study or expert opinion can't be relied upon. So, a review of existing literature has been carried out to know the safety and feasibility of segmental spinal anesthesia in current anesthesia practice. Relevant articles describing surgeries conducted under Segmental Thoracic Spinal anesthesia were studied and analyzed. Segmental Thoracic Spinal anesthesia is a feasible, safe and economical anesthesia technique for various abdominal and thoracic surgeries. It is also associated with less postoperative complications and patient satisfaction.

Keywords: Thoracic Segmental Anesthesia, Segmental Spinal, General anesthesia.

INTRODUCTION

Medicine is an everchanging science. New evidence replaces older protocols. Spinal anesthesia was previously advised only below the termination of spinal cord in the lumber region to avoid injury to cord. As anatomy of spine and its relation within spinal cord is more understood various case reports and feasibility studies were published in authentic journals [1]. In older and some high-risk patients, regional anesthesia offers several advantages with improved patient safety and satisfaction in laparoscopic surgeries [2-3]. Thoracic segmental spinal anesthesia is a neuraxial regional anesthesia technique that can potentially be a suitable alternative to general anesthesia for certain cases particularly in patients who are considered at high risk while under general anesthesia [4]. Although not routinely used and still not described in standard text books, the technique has been shown safe and effective in maintaining hemodynamic stability for such patients and reducing side effects encountered with general anesthesia in certain high-risk categories [5]. Thoracic segmental anesthesia due to its highly selective spinal block tailored to anesthetize required dermatomes only, need reduced dose of local anesthetics thereby lower risk of local anesthetic toxicity carries remarkable advantages of this technique compared to lumbar spinal anesthesia and other regional technique such as thoracic paravertebral block (TPVB) [6]. Similarly, *Naresh W Paliwal, Sunil S Lawhale* also concluded that segmental spinal with low dose of local anesthetics is associated with minimal hemodynamic fluctuations, minimal motor block, faster recovery, early ambulation and reduced postoperative pulmonary complications [7]. Practicing a new technology and designing policy decisions based on a single study or expert opinion can be misleading [8]. So, a scoping review of literature has been carried out to know the safety and feasibility of segmental spinal anesthesia in a variety of circumstances.

METHODOLOGY

We conducted extensive online literature search for articles using various search engine and database with keywords Segmental spinal, Thoracic spinal, Thoracic segmental spinal, Thoracic segmental anesthesia. Reference lists of all retrieved publications were also explored. Our search was limited to English language articles. IAK and SA reviewed the abstracts of all identified articles and the full text of all case reports, letters, original articles and reviews that seemed relevant to this review and prepared an initial draft.NP reviewed the initial draft and enriched it to develop final draft. All the three authors revisited the final draft and agreed upon.

RESULT

Relevant articles describing surgeries conducted under Segmental Thoracic Spinal anesthesia were studied and analyzed. Some important ones are compiled in Table 1.

Table 1: Some published articles on surgeries under Segmental Spinal anesthesia

Author, (year)	Type of Study	Patients No. (Age in year)	ASA- status/ Co-morbidity	Procedure	Conclusion
Van Zundert AA *et al.*, (2007)	Feasibility study	20 (18-75)	I and II	LC	SSA can be an effective anaesthetic technique for routine laparoscopic surgery.
Patel K *et al.*, (2012)	Case Report	1 (70)	Byssinosis	Nephrectomy	SA in a modified way, if followed, may provide additional advantage to patients
Calvo-Soto P *et al.*, (2012)	Randomized clinical study	24	I and II	LC	SGA may reduce postoperative morbidity in LC.
Ellakany M. (2013)	Comparative study	40	I and II	LC	TSA can be used successfully and effectively for LC in healthy patients by experienced anesthetists.
Vretzakis G *et al.*, (2013)	Narrative Review	>20809	Heterogeneous	Laparoscopic surgeries	Stressed on standard protocol before RA can be considered acceptable for routine use.
Elakany MH *et al.*, (2013)	Comparative study	40	I-III/ Primary breast cancer	Breast cancer surgery	STSA has advantages over GA and can be considered as a sole anaesthetic in breast surgeries
Imbelloni LE (2014)	Prospective observational.	369	Cholelithiasis	LC	LC can be performed successfully TSA with certain advantages.
Elakany MH *et al.*, (2014)	Double-blinded randomized controlled study	60	II-III/ Abdominal malignancy	Abdominal cancer surgery	STSA a feasible option for open abdominal surgeries with excellent perioperative course.
Mehta N *et al.*, (2015)	Case Report	1 (88)	COPD; NYHA-III	LC	Thoracic CSE with isobaric bupivacaine provides SA with minimal hemodynamic alteration and significant postoperative benefits.
Kejriwal AK *et al.*, (2017)	clinical case study	1 (45)	I	LC	STSA can be an effective and economical anaesthetic technique for routine laparoscopic surgery.
Paliwal NW *et al.*, (2020)	Review	Not specified	Heterogeneous	Abdominal and Thoracic surgery	Low dose SA is associated with remarkable cardiovascular stability and suitable alternative in select patients for various thoracic and abdominal surgeries. Patients with multiple Comorbidities.
Vincenzi P *et al.*, (2022)	Case Series	4 (77,68,75,83)	II-III/ HTN, DM, COPD, CMP	Breast and Axillary surgery	STSA as a safe, reliable, and adequate anaesthetic technique for breast and axillary surgeries particularly in frail and elderly patients.
Shatri G *et al.*, (2022)	Narrative Review	Not specified	Heterogeneous	Heterogeneous	TSA is a feasible, safe and economical technique.
Upadhyay S *et al.*, (2022)	Case Report	1 (55)	II/ Obesity, DM	Breast debridement	TSS is a feasible and safe technique for breast surgery.

Abbreviations used in table 1; ASA= American Society of Anaesthesiologists, SSA=Segmental Spinal Anaesthesia, SA= Spinal anaesthesia, TSS=Thoracic Segmental Spinal, SGA= Spinal General Anaesthesia, LC=Laparoscopic Cholecystectomy, TSA= Thoracic spinal anaesthesia,

RA= Regional anaesthesia, STSA= Segmental thoracic spinal anaesthesia, GA=General anaesthesia, CSE= Combined Spinal Epidural. HTN= Hypertension, DM= Diabetes, COPD= Chronic obstructive pulmonary disease, CMP= Cardiomyopathy.

DISCUSSION

Patient safety, Surgeon's satisfaction and Anesthesiologist's comfort are the three important points of an anesthetic technique along with other considerations. Operations that have been performed under thoracic segmental anesthesia with success include abdominal cancer surgeries, breast cancer surgeries, and laparoscopic cholecystectomies etc.

Safety

Magnetic resonance imaging (MRI) of thoracic spinal canal was assessed in 50 patients. The distance between the dura mater and spinal cord measured 5.19 mm at T2, 7.75 mm at T5, and 5.88 mm at T10. The distance between the needle tip and the posterior surface of the spinal cord was found more in MRI due to angulated entry between T5 and T6 (almost 50°). MRI also confirmed that the spinal cord and the cauda equina were touching the dura mater posteriorly in the lumbar region and anteriorly in the thoracic region. [9] This could be a possible explanation for the low incidence of neurologic complications during thoracic epidural block in an event of accidental perforation of the dura mater [10, 11]. Subarachnoid block above the termination of spinal cord requires extra caution, expertise and experience [12]. During Thoracic Segmental Anesthesia a decrease in catecholamines attenuates stress response due to complete blockage of the thoracolumbar sympathetic nervous system the adrenal medulla innervation via the T6 – L2 spinal nerves [13]. There is also low incidence of deep vein thrombosis with regional anesthesia [14]. Segmental spinal anesthesia has been used safely in patient with impaired lung function [15, 16]. *Standlt et al.,* found that spinal anesthesia causes lower incidence of postoperative complications and need for intervention as well as shorter observation time as compared to general anesthesia [17]. High Subarachnoid Block carries the possibility of inadequate ventilation owing to extensive thoracic nerve block. However, diaphragm which is the main inspiratory muscle remains unaffected because it is innervated from cervical level, and expiration is a passive phenomenon under normal condition. Although, coughing, voluntary deep breathing and forceful expiration are affected to some extent because they are enacted primarily by the intercostals and the anterior abdominal wall muscles which are innervated by the thoracic nerves [18]. Paresthesia can occur with any technique of spinal anesthesia, but are of potentially greater significance when the needle is inserted above the termination of the spinal cord. In a study conducted by *Imbelloni et al.,* incidence of paresthesia was found 6.6% during low thoracic spinal with no any permanent neurologic sequalae [19]. A highly selective and exclusive sensory block of the cervical roots without any impact on the motor function of the diaphragm to safely conduct opioid free Segmental spinal anesthesia in patients with chronic pulmonary disease and reduced reserve, representing the group that might benefit the most from a neuraxial approach was depicted in case series of *Vincenzi P et al.,* [20].

Advantage

There are a number of advantages to deliver the spinal anesthetic directly to the required level. Little caudal spread leads to sparing of blocked of lower extremities thereby lesser hemodynamic changes [21]. Total dose of required local anesthetics becomes low. The danger of cardiac and respiratory depression is also low. Another advantage is decreased anxiety and increased patient satisfaction owing to preserved motor power of extremities [22]. Regional block has been shown less chances of nausea and vomiting, when compared with general anesthesia [23]. *Elakany MH* found that single-dose thoracic spinal block using low dose local anesthetic as an adequate option for mastectomy. They also found quality of postoperative analgesia, lower incidence of nausea and vomiting, and shorter recovery time, with the consequent early hospital discharge [24].

Feasibility

Laparoscopic cholecystectomy is commonly performed under general anesthesia, but regional techniques have been shown to attenuate the metabolic and endocrine stress response with great efficacy and modulation of the stress response to surgery reduce postoperative morbidity and improve patient outcome [25]. It also lowers the length of the hospital stay as well as total cost of patient care [26]. Twenty cases of laparoscopic cholecystectomy were done successfully under combined spinal epidural technique at thoracic segment level. Authors concluded that segmental spinal anesthesia can be a feasible and safe anesthetic technique for routine laparoscopic surgery [27]. Similarly, *Patel K and Salgaonkar S* reported a case posted for nephrectomy with Byssinosis. They conducted the case under combined spinal epidural technique at thoracic segmental level [28]. *Upadhyay S et al.,* in their case report concluded that Thoracic segmental spinal anesthesia can be used successfully and safely for breast surgeries by experienced anesthesiologist with excellent patient and surgeon satisfaction [29]. *Vretzakis G et al.,* in their narrative review depending upon available evidence, believed the need of protocols to maintain patient comfort during surgery before Regional Anesthesia can be considered acceptable as the standard technique for routine laparoscopic surgery [30].

Economy

Comparatively lesser volume and concentration of medications are required to conduct TSA. Less hemodynamic changes need lesser fluid administration and lesser additional medications to deal with hypotension and brady/tachycardia. Reduced hospital stays and early return to daily life is an added advantage with segmental spinal over General anesthesia.

Disadvantage

Thoracic segmental spinal without sedation is not well suited to patients' group who don't prefer to remain awake during the procedure. Thoracic segmental spinal shouldn't be utilized by novice anesthesiologists with little experience.

CONCLUSION

Segmental Thoracic Spinal anesthesia is a feasible, safe and economical anesthesia technique for various abdominal and thoracic surgeries. It is also associated with less postoperative complications and patient satisfaction. Patients chosen for this technique need to be evaluated carefully and the technique is to be reserved for experienced clinicians with a good learning curve. The indication for thoracic spinal anesthesia needs to match the surgical needs of the patient. The safety of this technique needs to be confirmed by large randomized trials before it can be advised for routine use in healthy subjects as well.

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