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Original Article / Özgün Araştırma

Efficacy of the Stellate Ganglion Block Through the Lateral Approach Using Ultrasonogram and Fluoroscopy

Ultrason ve Floroskopi Kullanılarak Lateral Yaklaşımla Uygulanan Stellat Ganglion Bloğunun Etkinliği

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Abstract / Öz

Objective: Stellate ganglion (SG) block can provide pain relief in sympathetically mediated painful conditions. SG block at the sixth cervical (C6) vertebra level through lateral approach under the ultrasonogram (USG) guidance is very safe but may spare the fibres supplying the upper limb. When the drug is given at the C6 subfascially, it spreads along the cervical sympathetic chain, blocking the head/neck and upper limb. In this study, we assessed the efficacy of the SG block given at the C6 level after confirming the subfascial needle position under USG and downward spread of dye under fluoroscopy.

Methods: Ten patients with sympathetically mediated painful conditions belonging to the American Society of Anesthesiologists (ASA) Class I and II and aged between 18 and 60 years were included in the study. The SG was approached laterally under the USG guidance, and the dye was injected after confirming the subfascial needle position. A downward spread of dye was confirmed on fluoroscope, and 4 mL of 0.25% of bupivacaine with 40 mg of methylprednisolone was injected. Patients were assessed in terms of the pain relief, an increase in axillary temperature and adverse events after 30 minutes. A statistical analysis was done with Student's t-test and paired samples t-test.

Results: There was a statistically significant reduction in the post-block pain scores with the rise in temperature in the ipsilateral arm (p=0.000). The dye spread was observed from the fourth cervical vertebra to the first thoracic vertebra in all patients. Transient hoarseness was seen in 20% of patients, and the sensation of a lump was seen in 10% of patients.

Conclusion: We conclude that SG can be blocked effectively and safely through the lateral approach at the C6 level under ultrasonogram and fluoroscopic guidance.

Keywords: Stellate ganglion block, ultrasonogram guidance, fluoroscopic guidance, pain scores, hoarseness

Amaç: Stellat ganglion (SG) bloğu sempatik kökenli ağrı durumlarında, ağrının giderilmesini sağlayabilir. Ultrasonografi (USG) eşliğinde lateral yaklaşımla altıncı servikal vertebra (C6) düzeyinde uygulanan SG bloğu üst ekstremiteyi besleyen lifleri koruduğu için çok güvenlidir. İlaç C6 düzeyinde sub-fasiyal olarak verildiğinde, baş/boyun ve üst ekstremiteyi bloke ederek servikal sempatik zincir boyunca yayılır. Bu çalışmada, USG rehberliğinde sub-fasiyal iğne pozisyonu ve floroskopi altında boyanın aşağı doğru yayılımı doğrulandıktan sonra C6 düzeyinde verilen SG bloğunun etkinliği değerlendirildi.

Yöntemler: Çalışmaya sempatik kökenli ağrısı olan ve ASA (American Society of Anesthesiologists) I ve II sınıfında yer alan 18 ile 60 yaş aralığında 10 hasta dahil edildi. Lateral yaklaşımla USG rehberliğinde SG uygulandı. Subfasiyal iğne pozisyonu doğrulandıktan sonra boya enjekte edildi. Boyanın aşağı doğru yayılımı floroskopi ile doğrulandıktan sonra, 40 mg metilprednizolon ile birlikte 4 mL %0,25 bupivakain uygulandı. Hastalar 30 dakika sonrasında ortaya çıkan yan etkiler, ağrının dinmesi ve aksillar sıcaklıkta artış açısından değerlendirildiler. İstatiksel analiz Student's t-test ve paired samples t-test kullanılarak yapıldı.

Bulgular: İpsilateral koldaki sıcaklık artışı ile birlikte blok sonrası ağrı skorlarında istatiksel olarak anlamlı bir azalma gözlendi (p=0,000). Tüm hastalarda boya yayılımının dördüncü servikal vertebradan ilk torasik vertebraya doğru olduğu görüldü. Hastaların %20'sinde geçici ses kısıklığı ve %10'unda kitle hissi görüldü.

Sonuç: Bulgularımıza göre SG bloğu, ultrasonografi ve floroskopi eşliğinde, C6 düzeyinde lateral yaklaşımla etkili ve güvenli bir şekilde kullanılabilir.

Anahtar Kelimeler: Stellate ganglion bloğu, ultrasonografi rehberliği, floroskopik rehberlik, ağrı skorları, ses kısıklığı

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Introduction

Stellate ganglion (SG) is a sympathetic ganglion formed by the fusion of the inferior cervical ganglion and the first thoracic ganglion. It contains sympathetic preganglionic fibres supplying the head and neck and sympathetic postganglionic fibres supplying the upper limb and heart (1). Blockade of the SG may result in analgesia in sympathetically mediated painful conditions such as complex regional pain syndrome (CRPS), vasculopathies and post-herpetic neuralgia (PHN) (2). The SG extends from the neck of the first rib to the lower border of transverse process of the seventh cervical vertebra (C_7) and is in continuation with the middle cervical ganglion, which is located at the sixth cervical vertebra (C_6) (1). Although the SG block has been practised for many years, there is no clarity about the safe technique for a successful block. The SG can be blocked at the C_6 level with the landmark technique and at the C_6 or C_7 level with the help of imaging tools like ultrasonogram (USG) and fluoroscopy. It can be accessed through anterior or oblique approach. Also, the site of injection can be intramuscular, subfascial or extrafascial. The landmark-guided technique is based on the location of the anterior tubercle of C_6. Variation in the size of anterior tubercle of C_6 and vicinity of the vertebral artery makes this technique vulnerable to complications and reduces the success rate (3). The SG can be blocked at C_7 under the fluoroscopic guidance but has the disadvantage of not visualising the surrounding structures such as vertebral artery, dome of pleura and oesophagus. These shortcomings can be overcome by USG as one can easily view the soft tissues, anatomic variations of cervical and vertebral arteries and other pathological conditions (4). The SG can be reached via the anterior-paratracheal or lateral approach under the USG guidance. The close proximity of major blood vessels and oesophagus in the needle pathway in the anterior approach makes it unsafe when compared to the lateral approach (5). Considering these facts approaching the SG laterally at the C_6 level under USG appears to be the safer technique. However, the blockade at C_6 may result in failure of pain relief for upper limb pathologies as there is a possibility of only blocking the middle cervical ganglion, which supplies the head and the neck (1, 6). A previous study of SG block performed at C_7 under USG guidance by the lateral approach in patients suffering from upper limb pathologies was found to provide analgesia with minimal adverse events (7).

Earlier, the location of the cervical sympathetic chain was considered to be superficial to prevertebral fascia, but now it is confirmed by the USG imaging and dissection that the sympathetic chain is located subfascially (8). Hence, when the drug was injected subfascially by the lateral approach under USG, it spreads from the fourth cervical vertebra to the first thoracic vertebra and blocks SG irrespective of the level of entry. This was proven by Gofeld et al. (8) in the study done in cadavers at the C_6 level under USG with its clinical validation in human beings under fluoroscopy. The spread of drug along the sympathetic chain was seen in healthy human volunteers, but the clinical benefits of the SG blockade in terms of pain relief and safety profile were not studied. Although the SG block at C_6 is safer than at C_7, the clinical efficacy of SG block performed at C_7 is proven to be better than at C_6 (1, 6). Hence, we decided to study the clinical efficacy of Gofeld's approach for the SG block at the C_6 level using USG and fluoroscopy (8). The objective of the study was to assess the success of block in terms of pain relief, post-block temperature change and safety profile.

Methods

This prospective study was conducted over a period of 1 year (June 2016-May 2017), after obtaining consent from the institutional ethics committee. The study has been registered in the clinical trials registry of India (CTRI/2017/04/008416). Ten patients suffering from sympathetically mediated painful conditions of the head, neck and upper limb such as complex regional pain syndrome (CRPS) I &II, post-herpetic neuralgia, phantom limb syndrome and vaso-occlusive disorder belonging to both the genders, aged between 18 and 60 years, and with the Numeric Pain Intensity Scale (NPIS) greater than 4 were included in the study. The patients with extremes of the body mass index (18<BMI>25), taking beta blockers, with a history of recent myocardial infarction, glaucoma, arrhythmias and deranged coagulation profile were excluded from the study.

The procedure was explained, and a pre-procedure informed consent was obtained from the patients. The block was performed in the operation theatre under minimal mandatory monitoring. All the patients were fasted for 6 hours prior to the procedure. The block was performed by an experienced anaesthesiologist, who had performed more than 100 USG-guided regional anaesthesia blocks and 10 SG block under fluoroscopy. The block was done under the USG guidance (Shenzhen Mindray Bio-Medical Electronics Co., Ltd) with a 10-15 MHz probe and fluoroscopy (C-arm, KMC 650). The pain intensity of the patients was assessed prior to the block by an anaesthesiologist on the day of procedure. The block was performed by the second anaesthesiologist. The post-procedure pain score was assessed by another anaesthesiologist in the recovery room, who was not aware of the pre-procedure pain score and intra-operative events. The axillary temperature was recorded on the side of the block.

The intravenous access was obtained with a 20 G cannula, and patients were sedated with 0.02 mg kg^{-1} of midazolam and 2 μg kg^{-1} of fentanyl. The patients were placed in the supine position with the neck slightly extended by placing a pillow under the shoulder and neck turned to the side opposite to the block site. Oxygen was administered to the patient with nasal cannula at a flow rate of 3 L min^{-1}. Under strict aseptic precaution, the fluoroscope was positioned so as to get a PA view of the cervical spine with C_6 and C_7 as the centre and stored as a reference image (Figure 1). The USG scanning was done with a 10-15 MHz probe in the transverse plane from medial to lateral at the level of C_6. The trachea, thyroid gland, carotid artery, internal jugular vein, longismus colli muscle and the transverse process of

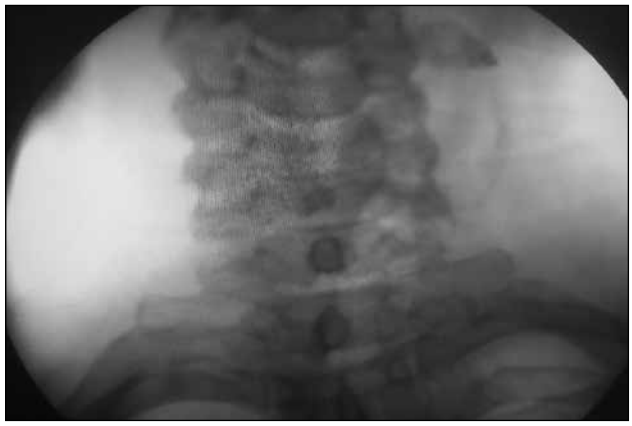

Figure 1. PA view of the cervical spine with C6 and C7

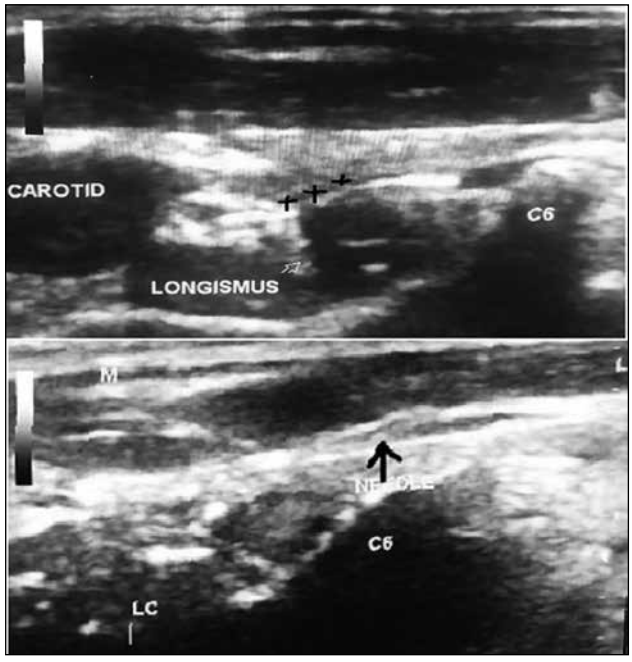

Figure 2. Needle tip between longismus colli and prevertebral fascia

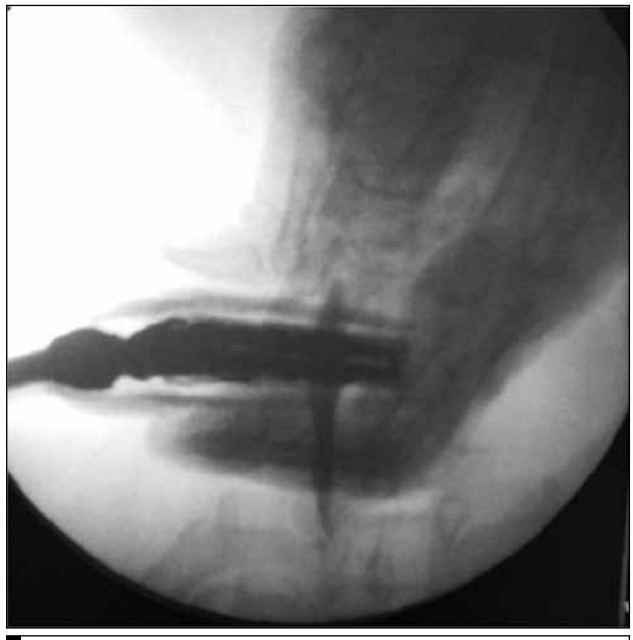

Figure 3. Spread of dye

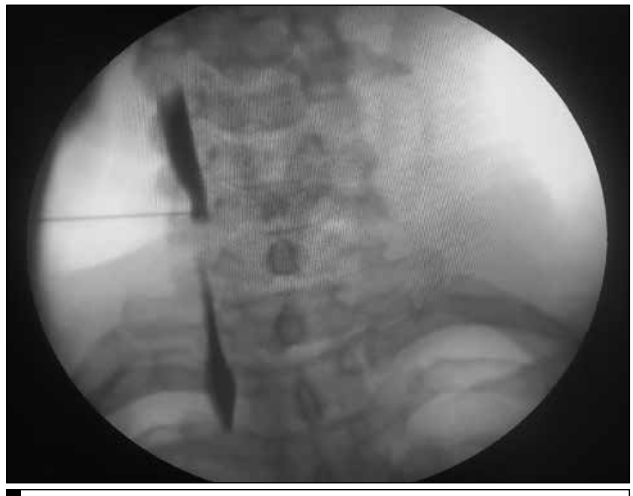

Figure 4. Spread of dye from C_4 to T_1

C_6 were visualised. The probe was placed in such a position so as to visualise the carotid artery and internal jugular vein anteriorly and transverse process posteriorly with the longismus colli in the centre for an in-plane technique (Figure 2). After local infiltration with 2 mL of 2% lignocaine along the lateral end of the probe, a 22 G spinal needle attached to a 10 cm extension tube was advanced between the carotid artery and anterior tubercle under real-time USG guidance. The needle tip was placed subfascially between the longismus colli and prevertebral fascia (Figure 2). Once when the position was confirmed, 1 ml of non-ionic contrast agent (Iohexol, omnipaque 350 mgI mL^{-1}) was injected, and a fluoroscopic image was obtained to assess the spread of the dye (Figure 3). Downward dye spread along the longismus colli was considered desirable (Figure 4). If the spread of the dye was not desirable, the needle was repositioned to obtain a preferred image. This was followed by injection of 4 mL 0.25% bupivacaine with 40 mg of depot methyl prednisolone. The patients were shifted to the post-operative recovery room and were assessed for pain relief, axillary temperature and safety profile after 30 minutes.

A primary outcome of the study was to compare the success of the block in terms of pain reduction and relief. The intensity of pain was assessed by the NPIS on the scale from 0 to 10, where 0 indicates no pain and 10 indicates the worst pain imaginable (9). The patients were graded as NPIS=0, excellent pain relief; NPIS=1&2, good pain relief; NPIS=3, average relief and NPIS>3, poor pain relief. The secondary outcome of the study was to assess temperature change in the upper limb, downward spread of dye on fluoroscopy, the incidence of Horner's syndrome and the safety profile. The safety profile was assessed by the incidence of the voice hoarseness, dysphagia, feeling of a lump in the throat, vascular injury, ipsilateral limb weakness

Table 1. Patient's characteristics

Parameter	Mean±SD
Age (Years)	49.3±6.70
BMI (kg m^{-2})	22±1.31
Sex M/F (Number)	7/3
Indications (Number)	
CRPS I	6
Post-herpetic neuralgia	4
Neck	2
Face	2

SD: standard deviation; M: male; F: female; BMI: body mass index; CRPS: complex regional pain syndrome

Table 2. Pain scale

Parameter	Pre-block	Post-block	p
NPIS	8 .1±0.73	1±1.4	0.000
Temperature (Fahrenheit)	97.65±0.35	99.05±0.20	0.000

NPIS: Numeric Pain Intensity Scale

Table 3. Adverse events

Parameter	Number (%)
Hoarseness	2 (20)
Dysphagia	0
Feeling of a lump in the throat	1 (10)
Vascular injury	0
Respiratory depression	0
Ipsilateral upper limb weakness	0

and respiratory depression. The axillary temperature was noted 30 minutes after the block. Changes in voice from baseline to a more breathy and raspy voice was taken as hoarseness of voice. The muscle power less than 4/5 in the upper limb was taken as weakness. A reduction in the oxygen saturation to less than 92% on room air was taken as respiratory depression. Patients were asked for feeling of a lump in the throat and its presence was noted. During the procedure, if there was any accidental vascular injury, it was noted on USG and fluoroscopy. Other signs for the involvement of the sympathetic chain were assessed with the presence of ptosis, anhydrosis and myosis.

Statistical analysis

Sample size calculations were based on a previous study, in which pain relief was noted in 36% of patients (10). The sample size of 9 patients was required to detect 50% of pain relief for the power of 80% and significance of 5%. Ten patients were included in the study. The statistical analysis was done using the Statistical Package for Social Sciences for Windows (Microsoft USA, version 23, Armonk, NY: IBM corporation and its licensors 2015). The distribution of data was analysed with the Kolmogorov–Smirnov test. Patient's characteristics were analysed with one sample Student's t-test, and data were expressed as the mean±standard deviation (SD). The NPIS and temperatures were analysed with the paired t-test and were expressed as the mean±SD. Safety profile parameters were expressed as number and percent. A p-value <0.05 was taken as significant for two-sided test.

Results

The patient's characteristics are shown in Table 1. The downward spread of dye up to T1 was observed in all the patients (Figure 4). The post-block NPIS scores (Table 2) were significantly reduced as compared to pre-block NPIS scores (p=0.000), and the CI was 5.95-8.24. Six patients had excellent pain relief with the NPIS of 0 at the end of 30 minutes. The pain relief was good in 2 patients, average in 1 patient and poor in 1 patient. An increase in the axillary temperature was statistically significant, p=0.000 (CI, 1.56-1.23). Ptosis was observed in all the patients. Post-procedure adverse events were purely restricted to hoarseness of voice (2 patients) and foreign body sensation in the throat in 1 patient (Table 3).

Discussion

In this study, we assessed the efficacy of the SG block performed by the lateral approach at C_6 under the USG and fluoroscopic guidance. We found a significant drop in the post-block NPIS scores, and an increase in axillary temperatures when compared to the baseline values were significantly less. Hoarseness of voice was seen in 20%, feeling of a lump in the throat in 10% and ptosis in 100% of patients.

The SGB is most commonly done at the C_6 level as this level provides well-defined landmarks and relative safety against an inadvertent intravascular injection. Most of the studies on the SGB are either based on the landmark technique or under fluoroscopy guidance. Very few studies have been done under the USG guidance, which are also at the C_6 level (5, 8, 11). Ghai et al. (7) have described the lateral approach to the SG at the C_7 level under USG. They found a statistically significant reduction in the post-block NPIS, which is similar to our results. However, the reduction in the post-block NPIS is greater in our study with a greater number of patients having an excellent pain relief. This could be due to a subjective assessment of pain by the NPIS and inclusion of a variety of painful conditions by Ghai et al. (7) Although the SG block is indicated in several conditions, the evidence scores based on several studies recommend it only for three conditions: namely, CRPS, vasculopathies and acute and chronic PHN (12-14).

In the study conducted by Ackerman et al. (10), the SG was blocked under fluoroscopic guidance in 25 patients suffering from CRPS. Forty percent of patients had an excellent pain

relief, 36% had a partial pain relief and 24% had no pain relief. The post-block pain relief in our study was slightly better, which could be due the accuracy provided by the USG guidance. Rise in the axillary temperature is one of the signs of the sympathetic block. There was a statistically significant rise in temperature after the block in our study, which was comparable to the results of the study done by Ghai et al. (7). Shibata et al. (11) studied the SG block under USG at the C_6 level, and they found changes in temperature in the ipsilateral limb. Jadon studied the efficacy and safety of the SG block performed at the C_7 level by an oblique fluoroscopic approach with 1-2 mL of dye. They targeted the junction between the uncinate process and the vertebral body to avoid vascular injury in CRPS patients (15). They observed an increase in temperature on the ipsilateral side without vascular injury. The dye spread was seen from the C_6 to the T_1 level in their study. In our study, we used 1 mL of dye, and its spread from C_4 to T_1 was confirmed before injecting the drug in all patients. From the studies done by Matsumotos and Malmqvist et al., it is clear that the block carried out at the level of C_6 was producing a successful sympathetic block of the head/neck with sparing of the upper limb as compared to the block done at C_7 (6, 16). This may be due to the fact that the middle cervical ganglion supplying the head and the neck is located at C_6 and SG, which supplies the upper limb at C_7/T_1. We had six patients with CRPS involving the upper limb in our study, and all of them had an increase in the axillary temperature with pain relief, which indicates a successful stellate ganglion block at the C_6 level. Harano has proved that the spread of injectate to the SG was seen in 45% of patients when the block was performed at C_6 and in 63% of patients when it was performed at C_7 (17). The bony landmark of C_6 or C_7 is only a surrogate marker of the sympathetic chain. The ideal location for performing the SG block is in the subfascial plane, superficial to the longus colli muscle. This can be identified only under USG. Once the needle is placed in the correct location under the USG guidance, the injectate spreads to C_7–T_1, even though the site of entry is C_6 (18). Gofeld et al. (8) have proved that the cervical sympathetic chain is superficial to prevertebral fascia, and when the drug is injected accurately under USG, it spreads from C_4 to T_1, there by blocking the SG irrespective of the level of entry (8). We studied a clinical validity of the SG block by a technique described by Gofeld et al. (8), in which the SG was accessed safely via the lateral approach at the C_6 level under USG, and the position of needle was confirmed by the spread of the dye under fluoroscopy. In our study, we injected the drug after confirming the dye spread to the T_1 level. We found that there was an increase in the axillary temperature on the ipsilateral side along with a statistically significant reduction in the post-block NPIS. Our results are similar to the results of a study done by Ghai et al. (7), in which the SG was accessed at the C_7 level under the USG guidance without the aid of fluoroscopy. Identifying the C_7 vertebra on USG and blocking the SG at that level can be technically demanding with a risk of a block failure (19).

The incidence of temporary hoarseness of voice in the present study was 20%, which was similar to a study by Jadon and Ghai et al. (7, 15). The cause of temporary hoarseness in our patients could be due to spillage of drug into the trachea-oesophageal groove. Shibata et al. approached SG ganglion paratracheally under USG at the C_6 level. They found that hoarseness of voice was not seen if the drug was injected correctly in the subfascial plane, but hoarseness was present if the drug was deposited suprafascially (11). Shibata et al. injected 1% of lignocaine without steroid, which could have spared the blockade of recurrent laryngeal nerve in subfacial injections. However, they used a large volume of local anaesthetic agent which could have spread to the trachea-oesophageal groove when given suprafascially. Hoarseness could be a presenting sign of retropharyngeal haematoma following the SG block; however, the incidence of haematoma following the USG-guided SG block was zero (20, 21).

One of our patients complained of the presence of a lump in the throat, which was transient and relieved after 2 hours. Two patients had similar complaints in the study by Gofeld et al. (8). In our study, none of the patients complained of a persistent foreign body sensation, which is usually due to the blockade of the external laryngeal or recurrent laryngeal nerve resulting from the local anaesthetic spread (22). Injury to the oesophagus can also present in a similar fashion. The oesophagus is located abnormally in 5% of population, and its lateral deviation increases from 50% at the C_6 level to 74% at the C_7 level (21). Although an exact incidence of the accidental oesophageal puncture is not known, the probability of injuring it is greater at C_7 (21). Respiratory distress following a SG block could be due to pneumothorax or spillage of drug resulting in the phrenic nerve block, which was not seen in any of the patients. In this study, blocks were performed at C_6 under the USG guidance, thus avoiding an injury to pleura. The amount of the local anaesthetic agent was less than 5 ml; hence, spreading of the drug to the phrenic nerve and brachial plexus was not seen (20, 23).

In our study, changes in temperature after the SG block were noted in all the patients. However, a change in temperature does not always indicate a successful sympathetic blockade, and hence, monitoring with laser Doppler flowmetry is needed (24). The limitation of our study was that we did not monitor the blood flow of the ipsilateral side with laser doppler. Another limitation of our study was that we could not compare the success of the SG block performed for the head and neck pathologies and upper limb pathologies. Further studies are needed to prove the efficacy of the C_6 level block under USG and fluoroscopy, while comparing between the upper limb and head/neck pathology.

Conclusion

We conclude that the SG ganglion can be blocked effectively and safely through the lateral approach at the C6 level under the USG and fluoroscopic guidance.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Shri Sathya Sai Medical College and Research Institute.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

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