Sympathetic Blocks in Pain Practice

Chair

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Sympathetic ganglion block has been performed since WWI in the management of various types of sympathetically mediated pain diseases. The loss of regular inhibitory influence on pain and adrenergic hypersensitivity is considered as a part of pathophysiology in those pain conditions. Despite the frequent use of minimally invasive sympathetic blocks by pain physicians, their efficacy for providing analgesia has been sparsely reported. Several case reports and series have been published, however, few placebo-controlled, blinded studies exist. In this presentation, we examine the available evidence of common sympathetic blocks in pain management.

I. Stellate Ganglion Block

Although stellate ganglion block (SGB) was first conducted for the treatment of angina pectoris, it is nowadays used for diagnosis and management of sympathetically mediated pain conditions such as CRPS I and II and vascular insufficiency of the upper extremity including Raynaud diseases. Although systematic evidence is lacking, extensive case reports exist for the use of SGB in phantom pain, postherpetic neuralgia, cancer pain, cardiac arrhythmias, orofacial pain, and vascular headache. More recently, SGB has been used with some success in treating psychiatric conditions including anxiety and posttraumatic stress disorder.

Evidence for SGB is limited mostly to case reports and case series; however, there exist a number of moderately sized studies aimed at systematically evaluating its efficacy in prospective randomized, blind-controlled studies. In a previous study by Price, et al. patients who were diagnosed with CRPS and conducted SGB did have a longer duration of pain relief than patients with placebo. In more recent prospective randomized controlled studies, SGB has been used in the perioperative setting. Kumar, et al. showed that postoperative tramadol consumption was significantly less for those who received ultrasound-guided SGB with lidocaine for upper-extremity orthopedic surgery.

II. Celiac Plexus Block

Celiac plexus block (CPB) neurolysis is used to provide analgesia for refractory visceral cancer pain in the upper abdomen, mainly due to pancreatic cancer. CPB has been extensively studied, and its efficacy and benefits have been demonstrated in multiple peer-reviewed publications. Wong, et al. conducted a double-blind randomized controlled trial comparing percutaneous CPB to opioid analgesia in 100 patients with unresectable pancreatic cancer and found that pain intensity at 1 week decreased by 53% in the CPB group compared to 27% in the control group. Then, during the 6-week follow-up, 40% of patients in the control group reported moderate-severe pain compared to 14% in the CPB group. Another double-blind
randomized controlled trial compared an early application of the block to pharmacological management in 96 patients with an inoperative pancreatic cancer. The reduced pain was noted in the treatment group at 1 and 3 months without a corresponding increase in the use of opioid analgesia. On the contrary, increased pain intensity and morphine use were recorded at both time points in the control group. In addition, reduced pain and opioid use derived from CPB have been substantiated by two large systematic reviews of eligible publications and meta-analysis of 7 RCTs.

III. Lumbar sympathetic block

Fluoroscope-guided Lumbar sympathetic block (LSB) was first conducted in 1944. LSGB is most commonly used for the diagnosis and treatment of various lower-extremity pain states including CRPS I and II, peripheral neuropathic pain, and ischemia-related pain, which is thought to have sympathetic components. It can be also used to palliative pain in lower extremities because of vascular insufficiency, including frostbites, Berger disease, atherosclerosis, and collagen vascular diseases. Despite the long history its use, LSB currently lacks a strong RCT basis for its use in sympathetically mediated pain, with most publications revolving around case reports or case series. The largest double-blind RCT for LSB was performed by Cross, et al. who observed a statistically significant reduction in rest pain at 1 week and 6 months in LSBs performed with phenol compared with bupivacaine. Meier, et al. performed a double-blind, placebo-controlled trial in children aged 10 to 18 years and found significantly more pain reduction for patients who received LSB compared with placebo.

The block may also be utilized in the setting of malignancy to abolish lower extremity pain from tumor invasion of the spinal canal or of the peripheral tissues. It has also been used with good outcomes to relieve bladder spasms in patients diagnosed with bladder cancer and to treat lower extremity lymphedema in patients with gynecological cancers.

IV. Superior hypogastric plexus neurolysis

Superior hypogastric plexus block (SHPB) was first described in 1990 for pelvic pain. It has since gained popularity as a diagnostic technique used to determine if pelvic pain is sympathetically mediated via the hypogastric plexus. It is also used as therapy for sympathetically mediated pelvic pain. Destruction of the plexus may be therapeutic in patients with acute and chronic pelvic pain, cancer pain of the pelvic viscera, or neuropathic pain from trauma or endometriosis. SHPB has also shown utility in sympathetically mediated rectal pain. The largest prospective cohort study evaluating SHPB was performed by Plancarte et al in 1997. Over a 3-year period, 227 patients with pelvic pain were enrolled and received bilateral percutaneous neurolytic SHPB with 10% phenol after a successful diagnostic block with 0.25% bupivacaine. Seventy-two percent of the 159 patients who responded to a diagnostic block had a visual analog pain score 4/10 or less, 62% after 1 block, and 10% after a second block. Additionally, the patients treated with the neurolytic blocks reduced their opioid consumption by 43%. Substantial pain control, decreased opioid utilization, and improved quality of life was shown by a recent randomized controlled trial of 50 patients with gynecological cancer, which reported more pronounced pain relief in the SHPB compared to the control (morphine) group, but which failed to show statistical differences in morphine consumption or improved functioning between the two groups.

V. Ganglion impar block

Ganglion impar neurolysis (GIB) is used to relieve the visceral and sympathetic pain of the perineal or pelvic area due to malignancies of the distal alimentary tract, urogenital system, external genital organs, and perineum not amenable to conventional treatment options. Evidence supporting the use of this technique in cancer pain treatment is limited; nonetheless, it consistently shows favorable outcomes and >50% pain reduction in the assessed participants.
VI. Different sympathetic neurolytic blocks

Different sympathetic neurolytic blocks can be combined in cases of widespread abdominal and pelvic pain from an extensive malignant disease. For example, combined celiac and SHPB has been done on 52 patients with advanced upper abdominal cancer and provided a level of pain relief that was superior to either of the blocks performed alone. A combined SHP and GI neurolysis has been attempted on 15 patients with pelvic and/or perineal pain, 10 of which attained a pain relief close to 70%.

References

The sympathetic nerve system is implicated in situations that involve emergent action by the body and additionally plays a role in mediating pain states and pathologies in the body. Sympathetic block was originally intended to diagnose sympathetic mediated pain, but it is now one of the typical procedures performed in pain clinics for purpose of controlling various refractory pain, ischemic conditions, and hyperhidrosis. Here, We will review several representative sympathetic blocks used in pain clinics.

**Stellate ganglion block (SGB)**

Stellate ganglion block is the most representative sympathetic block. Stellate ganglion is composed of the inferior cervical ganglion and the first thoracic ganglion fusion. It is located medial to the scalene muscles; lateral to the longus colli muscle, esophagus and trachea, along with the recurrent laryngeal nerve in between; anterior to the transverse processes; superior to the subclavian artery and the posterior aspect of the pleura; and posterior to the vertebral vessels at the C7 level (1) (Fig. 1). The preganglionic fibers of the stellate ganglion continue to travel through the cervical sympathetic chain, and the postganglionic fibers provide the sympathetic innervation of the upper limbs. Stellate ganglion provides sympathetic input to the ipsilateral upper extremity, chest, face, and head. SGB with local anesthetic exert their effect both on preganglionic and postganglionic fibers.

The therapeutic effects of SGB are due to these factors:

1. Block in neural connections in its region of innervation
2. Improvement in the blood supply of the region
3. Reduction of adrenal hormones plasma concentration

It can be used in various medical conditions besides pain conditions (Table 1).
Table 1. Indications of SGB

<table>
<thead>
<tr>
<th>Painful disease</th>
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<tbody>
<tr>
<td>Complex regional pain syndrome (CRPS) of the head and upper limbs</td>
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<tr>
<td>Postherpetic neuralgia (PHN)</td>
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<td>Chronic post-surgical pain</td>
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<td>Orofacial pain</td>
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<td>Phantom limb</td>
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<td>Atypical chest pain</td>
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<td>A cluster or a vascular headache</td>
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<td>Vascular disease</td>
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<td>Peripheral vascular disease in upper limbs</td>
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<td>Upper extremity embolism</td>
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<td>Raynaud disease (upper limb)</td>
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<td>Scleroderma</td>
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<td>Intractable angina</td>
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<tr>
<td>Others</td>
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<tr>
<td>Post-traumatic stress disorder</td>
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<tr>
<td>Hot flushes</td>
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<tr>
<td>Meniere syndrome</td>
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<tr>
<td>Refractory cardiac arrhythmias</td>
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<td>Bell's palsy</td>
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It is the oldest and most common sympathetic block that is applied today and has been performed by blind technique traditionally. As the imaging techniques improved in the last century, SGBs have started to be done with imaging guidance like fluoroscopy or computed tomography (CT). And, nowadays, ultrasound (US) guidance has become widely preferable. Blind technique can be done by palpating the anterior transverse process of C6 (Chassaignac tubercle), and injecting the local anesthetic immediately medially. But, with imaging guidance, injection can be done on the fascia of longus colli muscle at C7 which is closer to stellate ganglion (Fig. 2). This block is considered successful by the development of Horner’s syndrome, increase in skin temperature, increase in blood flow.

Fig. 1. Location of stellate ganglion
Thoracic sympathetic ganglion block (TSGB)

Thoracic sympathetic ganglion block (TSGB) can be used for sympathetically mediated pain in upper extremities and trunk. Particularly TSGB at T2 or T3 can be used for sympathetically mediated pain in upper extremities which does not respond to SGB. In addition, TSGB can be used for intractable cardiac and abdominal angina, post-thoracotomy pain, acute herpes zoster, palmar hyperhidrosis, postherpetic neuralgia, and phantom breast pain after mastectomy.

The 1st thoracic ganglion is fused with the lower cervical ganglion to help make up the stellate ganglion. As the chain moves cauda, it changes its position with the upper thoracic ganglia just beneath rib and the lower thoracic ganglia, moving more anterior to rest along the posterolateral surface of the vertebral body. The pleural space lies lateral and anterior to the thoracic sympathetic chain (Fig. 3) (2).
Jinyoung Oh: Commonly used sympathetic Block in Pain Practice

This block can be performed with fluoroscopically or CT guided technique using a posterior oblique approach. With fluoroscopic guide, the needle tip should be located at the lateral margin of the costovertebral articulation on AP view and just anterior to the costovertebral articulation of body (or posterior one-third of the vertebral body) on lateral view (Fig. 4).

![Fig. 4. Fluoroscopic guide thoracic ganglion block at T2 level. (left) lateral view (right) AP view. Circle: costovertebral articulation at vertebral body](image)

This procedure is less used than other sympathetic blocks because of high risks from proximity of the thoracic sympathetic chain to the somatic nerve and pleura and possibility that the sympathetic chain block is also possible with the paravertebral block (3).

**Lumbar sympathetic ganglion block (LSGB)**

Lumbar sympathetic ganglion block is most commonly used for the diagnosis and treatment of various lower-extremity pain states including CRPS I and II, peripheral neuropathic pain, and ischemia-related pain, which are thought to have sympathetic components (4).

The lumbar sympathetic chain consists of 4 to 5 paired ganglia that lie over the anterolateral surface of the L2 through the L4. The cell bodies lie in the anterolateral region of the spinal cord from T11-L2 with some contribution from T10 and L3. Sympathetic fibers accompany all major nerves to the lower extremities.

The location and number of the lumbar sympathetic ganglia are variable. Murata et al. reported four lumbar sympathetic ganglia (on the L2 vertebra, the L2-L3 disc, the L3-4 disc, and the L5 vertebra) and demonstrated that the sympathetic trunk runs on the anterior surface of vertebral column from L1 to L4 levels and then passes to the lateral side. In their study, sympathetic ganglia were distributed mainly on the L2 and L3 vertebrae (Fig. 5) (5).
Fig. 5. Various location of lumbar sympathetic ganglion. Most of them distributed mainly on the L2 and L3 vertebrae (cadaver study by Murata et al.) (5)

Lumbar sympathetic ganglion blocks are commonly blocked at the lumbar vertebral levels of L2-L4. All sympathetic fibers pass through or synapse at the L2 ganglion, so in theory, a block at the upper level of L3 should abolish all the sympathetic supply to lower limb (6). Single injection of 10-25mL of injectate (local anesthetics, neurolytic agents) at the L3 level is preferred in usual (Fig. 6), but, some study that a multilevel approach seem to be more efficient when compared to a single-needle method (7). In the past, blind techniques relying on surface markings have been used, but, not shown to be valid. Since the imaging device was developed, image guiding procedures have been mainly performed. Fluoroscopy or CT are used in common, and, nowadays, using ultrasound has been emerged (8).

Fig. 6. (a) Cross-sectional schema of lumbar sympathetic ganglion at L3. (b) lateral and (c) AP view of lumbar sympathetic block at L3 under fluoroscopic guide
Celiac plexus block (CPB) or splanchnic block

The celiac plexus is a network of ganglia that relays preganglionic sympathetic and parasympathetic efferent fibers and visceral sensory afferent fibers to the upper abdominal viscera. This plexus receives afferent fibers from the greater (from T5-T10), lesser (from T10-T11), and least (from T12) splanchnic nerves. This plexus serves as a relay station for sympathetic fibers supplying the abdominal viscera through multiple ganglia. These viscera include the pancreas, liver, biliary tree, and the gallbladder, spleen, stomach, small bowel, kidneys, mesentery, and ascending and partially the transverse colon (4).

Celiac plexus block is typically performed for cancer related visceral pain originating in the upper abdomen. Controlling pancreatic cancer pain through the celiac plexus block is the most representative form of intervention for cancer pain, and it can also be used for pain from stomach, duodenum, proximal small bowel, and corresponding lymph nodes.

This procedure can be performed by both anterior approach and posterior approach. Fluoroscopic or CT guided technique is usually used in common and ultrasound guided technique has also been introduced recently (4). In the anterior approach, a needle is inserted through the anterior abdominal wall directly into the region of the celiac plexus. This approach has advantages that it can be performed with supine position and reduced risk of accidental neurologic injury related to the retrocrural spread of drug to somatic nerve roots or epidural and subarachnoid spaces (9). Posterior approach is preferred when it is possible because that anterior approach has risk of complications from injury of major organs and vessels in the abdominal cavity. The posterior approach is performed at the level of T12-L1. Needle can be advanced either to celiac ganglion after penetrating crura and aorta (transaortic approach) or to the space of splanchnic nerves passing right behind the crura (retrocrural approach) (Fig. 7). The latter method is used more often, but the latter method is more appropriate for a splanchnic nerve block (Fig. 8). Theorically, the former has advantages of complete block with a single needle and low risk of spinal nerve block, but, has the burden of passing through aorta. The latter is less burden of passing the aorta, but, the risk of spinal nerve block is higher. No study has been proved that which one is better and selecting the appropriate approach based on an individual evaluation of each patients, balancing the possible advantages and disadvantages in a specific clinical situation (10).

Fig. 7. Schema of celiac plexus block with posterior approach (a) retrocrual approach (b) transaortic approach
Complications of CPB differ from approach to approach. Majority of the reported complications are transient and minor, with back pain being the most common one followed by orthostatic hypotension and transient diarrhea. Other severe complications of CPB include neurologic injuries such as monoplegia and anal and bladder sphincter dysfunction, monoplegia and anal and bladder sphincter dysfunction, pneumothorax, arterial injury, local hematoma, pleuritis, transient hematuria, pericarditis, intervertebral disk injury, retroperitoneal abscess, spinal cord injury or ischemia. However, no study assessed complications as a primary outcome (9).

Superior hypogastric plexus block

Superior hypogastric plexus is caudalward continuation of abdominal aortic plexus and inferior mesenteric plexus which is secondary plexus of celiac plexus. It is usually located in L4 to S1 level and anterior to aortic bifurcation and between the left and right common iliac arteries and posterior to the psoas fascia and peritoneum (Fig. 9). This plexus innervates the pelvic viscera through the hypogastric nerves and inferior hypogastric plexus.

Superior hypogastric plexus block is indicated for visceral pain originating from the pelvic organ. This plexus contains sympathetic fibers and visceral afferents and afferent pain fibers innervating pelvic organ travel with sympathetic nerves that originate from superior hypogastric plexus. Therefore, the sympathetic block at this level can be used to treat pain from pelvic area. Pain from endometriosis, chronic benign pelvic pain, proctalgia fugax can be indications of this procedure. It is also shown utility in sympathetically mediated rectal pain. But, evidence about the procedure for these conditions is mainly on a case reports level.

To describe based on the vertebrae, this plexus lies in front of L5-S1 junction. Thus, for this block the target is anterolateral portion of the L5-S1 interspace. Two-needle method introduced by Plancarte et al. is traditional approach and mostly used (11). For this approach, one of the important things is to maximize the space between the transverse process of L5 and the sacral alae, but, sometimes it is difficult to make the space to pass the needle (Fig. 9). Alternately, transdiscal approach with one needle can be used (12). This procedure is performed under fluoroscope or CT in usual, but, ultrasound also can be used (4).
Ganglion impar block

Ganglion impar (ganglion of Walther) is the fusion of the ganglia from both side of sympathetic chain at the level of the sacrococcygeal junction (Fig 10). This solitary ganglion receives sympathetic and parasympathetic fibers at the lumbar and sacral levels, and provides nociceptive and sympathetic fibers to the perineum, distal rectum, perianal region, distal urethra, vulva/scrotum, and the distal third of the vagina. It also supplies sympathetic innervation to the pelvic viscera (9). Thus, ganglion impar block is useful to the management of sympathetically mediated pain in the perineum, rectum, and genitalia. It has been primarily used for malignancies in these organs; however, it has been used for treatment of associated syndromes such as radiation enteritis, proctalgia fugax, and CRPS. It is retroperitoneal structure located at or slight below the ventral surface of sacrococcygeal joint and posterior to rectum.

Initially, a method of inserting the needle through the anococcygeal ligament was used, but after the introduction of the needle through the sacrococcygeal disc was introduced, it is widely used (trans-sacrococcygeal approach). With trans-sacroccygeal approach, the path of the needle is short and the needle can be straightly directed toward the ganglion impar (Fig. 10). However, in some cases, the needle cannot pass through the sacrococcygeal disc (e.g., calcification). In these cases, paracoccygeal approach which is the needle inserts from the below of both side transvers processes of coccyx can be used (13).

The ganglion impar is close in proximity to the rectum. Risk of contamination is increased through the needle track as the needle is removed. Infection and fistula are possible complications in patients who are already immunocompromised or have received radiation to the perineum. Other possible complications include motor, sexual, bladder, and bowel dysfunction, perforation of rectum and sciatic nerve impingement. But, complications of ganglion impar block are rarely reported. Overall, it is considered a safe and effective treatment in perineal and coccyx pain (9).
Fig. 10. (a) Location of ganglion impar (ganglion of Walther) in front of sacrococcygeal junction (b) ganglion impar block with transdiscal approach under fluoroscopic guid

References

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Thoracic sympathectomy is an important option in the treatment of palmar hyperhidrosis and pain disorders. Earlier surgical procedures were highly invasive with known morbidity, acceptable outcome, and established recurrence rates that were the limitations to considering surgical treatment.

The only treatment with long-term results involves surgical interruption of the sympathetic chain. These nerves primarily affect blood flow to the skin and the function of the sweat glands. Interrupting the sympathetic nerves in the chest results in dilation of the veins and arteries in the arm and hand as well as the blockage of sweating.

Thoracoscopic sympathectomy is a minimally invasive procedure that allows detailed visualization of the sympathetic ganglia and minimal postoperative morbidity.

Surgical sympathectomy for the treatment of disabling pain syndromes was introduced long time ago. The concept that many neuropathic pain syndromes (traditionally this definition would include complex regional pain syndromes (CRPS)) are “sympathetically maintained pains” has historically led to treatments that interrupt the sympathetic nervous system. Chemical sympathectomies use alcohol or phenol injections to destroy ganglia of the sympathetic chain, while surgical ablation is performed by open removal or electrocoagulation of the sympathetic chain.

In rare cases, arrhythmia is another one of indication for sympathectomy as well. Ventricular arrhythmias (VA) are precipitated by an increase in sympathetic activity, typically physical exercise. As such, beta blockade is the cornerstone of medical treatment. However, some patients are either intolerant or refractory to beta-blockers, and many continue to have arrhythmias despite catheter ablation. Cardiac sympathetic denervation (CSD), the surgical resection of the lower half of the stellate (cervicothoracic) ganglion and T2 to T4 sympathetic ganglia, has been shown to be effective in the setting of refractory VA.