Retrospective Study

Percutaneous Endoscopic Intercostal Neurectomy for Refractory Intercostal Neuralgia

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Background: Refractory intercostal neuralgia is a troublesome disease with long treatment cycle and short-term therapeutic effects. No treatment modality has given effective pain relief. The authors present here a safe and effective endoscopic surgical option for refractory intercostal neuralgia.

Objectives: To introduce the surgical techniques of percutaneous endoscopic intercostal neurectomy used for refractory intercostal neuralgia and to evaluate its safety and efficacy.

Study Design: A retrospective study.

Setting: The Department of Orthopedics at the Hebei General Hospital in China.

Methods: Thirteen patients with refractory intercostal neuralgia were treated with percutaneous endoscopic intercostal neurectomy. Patients were followed up to 12 months postoperatively. The pain was measured by the Visual Analog Scale (VAS) score. Complications, such as aspiration, dysfunction, infection, and local hematoma were analyzed.

Results: Pain was relieved in all 13 patients, with only 1 patient reporting burning sensation along the intercostal nerve distribution area after operation. No other complications were found. All patients had significant improvement, with significantly lower VAS scores recorded postoperatively. No recurrence was reported during the follow-up period.

Limitations: The retrospective nature of this study is a limitation, as well as the small sample size and short observation time.

Conclusions: Endoscopic intercostal neurotomy is an effective and safe minimally invasive surgical treatment for refractory intercostal neuralgia.

Key words: Intercostal neurectomy, minimal invasion, percutaneous endoscopic, refractory intercostal neuralgia

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Intercostals neuralgia is a subjective symptom, including a sharp or burning pain (1), caused by the damage on thoracic nerve caused for a variety of reasons. Moreover, pain may be dramatically exacerbated by physical activities or unexpected movements, such as laughing, coughing, sneezing, or even breathing, causing both physical and mental disorders (2), which can significantly reduce the quality of life. Nowadays, there are several treatment options available, like systemic medications, acupuncture (3), physical therapy, and invasive nerve blocks (4,5); however, refractory intercostal neuralgia, which is caused by Herpes Zoster virus infection, post-thoracotomy, and thoracic vertebral fracture, has traditionally been difficult to treat. The conventional treatments of refractory intercostal neuralgia often need to be repeated and fail to offer long-term therapeutic effects, which make it challenging. No single treatment modality has been

considered curative for the treatment of refractory intercostal neuralgia (6).

Several studies have shown that surgical neurectomy of intercostal nerves is an effective treatment for severe intercostal neuralgia (7-9). But the situation is much different for elderly patients with multiple medical diseases. Open surgery is undoubtedly traumatic, high-risk, and no more beneficial than preoperative surgery; therefore, open surgery fails to be the best method of treatment.

Radiofrequency ablation is a new technique for neuropathic pain. It has been shown to be effective in the treatment of chronic pain, including trigeminal neuralgia, post-herpetic neuralgia (PHN), and so on (10,11). But it is also important to note that the completion of this treatment requires cooperation of the patient. Patient cooperation is necessary because the radiofrequency ablation technique needs to be guided by x-ray, computed tomography (CT), or ultrasound to complete the location of puncture through repeated stimulation and fine-tuning the position of radiofrequency needle, finally determining the target nerve from feedback from the patient (12). So, the efficacy is uncertain due to dependence on cooperation with the patients. Apart from the unclear mechanism of this technique, the small sample size and short observation time make it difficult to recommend for broad use for relieving chronic, refractory pain (6,13,14).

Improvements in endoscopic technology, surgical technique, and the further understanding of the disease process have helped the extension and success of this operation. To the best of our knowledge, in this report, we present the first description of the successful use of percutaneous endoscopic intercostal neurectomy for refractory intercostal neuralgia. The aim of the present study is to introduce the surgical techniques of percutaneous endoscopic intercostal neurotomy in treating refractory intercostal neuralgia and to evaluate the efficacy, as well as the safety of the procedure.

Methods

The clinical data of 13 patients with refractory intercostal neuralgia treated by percutaneous endoscopic intercostal neurotomy from August 2014 to December 2017 at the Hebei General Hospital were retrospectively analyzed. Finally, all of the 13 patients were included in the present study.

Inclusion criteria were as follows: 1) presence of pain in the distribution of one or more intercostal nerves; 2) recurrence after temporary active response to oral administration of neurotrophic substances and nonsteroidal anti-inflammatory drugs and/or intercostal nerve block; 3) duration of symptoms of more than 3 months; 4) no other surgical contraindications.

Exclusion criteria were as follows: 1) patients who were infected in the site of the surgical approach; 2) patients with a major psychiatric disorder or other serious medical conditions.

Surgical Methods

Surgical Instruments

The instruments were the same as those used for percutaneous endoscopic lumbar discectomy.

Operating Procedure

According to the short-term relief of pain after intercostal nerve block and combined with preoperative clinical manifestations, or CT results showing narrowing of the corresponding intervertebral foramen, the nerves that needed to be transected were determined.

Under local anesthesia (the approximate amount used was 10 mL of 1% lidocaine for the entire case), the surgery was performed with the patient in the prone position on a radiolucent table. Preoperatively, the target segment and puncture path were determined under the guidance of x-ray fluoroscopy. Then, the puncture site was located at approximately 6 to 8 cm lateral to the midline and marked on the skin (Fig. 1). Using C-arm x-ray machine guidance, alternating between lateral and anterior-posterior (AP) views, an 18-gauge needle was inserted through the puncture site and placed at the intervertebral foramen. Subsequently, the guide wire was inserted and the puncture needle was removed after fluoroscopic confirmation of proper positioning. A 7 mm incision was made in the center of the puncture point on the skin. The sequential dilators were passed through the soft tissue. The final working cannula was then placed along the dilators (Fig. 2) and the endoscopic system was used. Hemostasis was achieved with a radiofrequency probe. Removing the adipose tissue, the targeted intercostal nerve in the intervertebral foramen was clearly visible under the endoscopy (Fig. 3). Then, symptoms were reconfirmed by stimulating the intercostal nerve and the intercostal nerve was severed with a special endoscopic clamp under direct vision (Figs. 4 and 5). After ensuring the patient's symptoms were significantly relieved, the endoscopic instruments were withdrawn and the incision (7 mm) was closed with absorbable sutures without a drain.

Fig. 1. *The planed entry point and puncture path on the skin surface.*

Fig. 3. *Intraoperative endoscopic camera image demonstrating the intercostal nerve, → show the targeted intercostal nerve.*

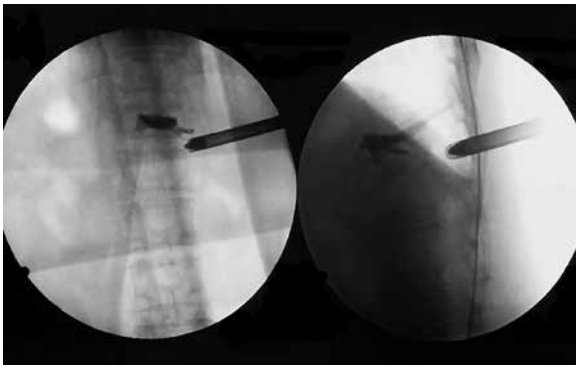

Fig. 2. *Intraoperative lateral and AP fluoroscopic images demonstrating the placement of the working cannula.*

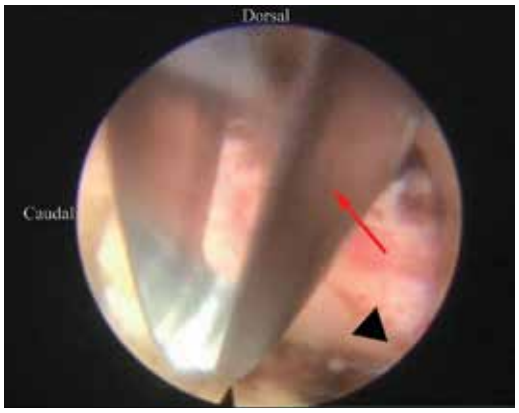

Fig. 4. *The intercostal nerve was severed with a special endoscopic clamp. → show the endoscopic clamp. ▲ show the targeted intercostal nerve.*

On the same day, after operation, the patient rested in bed and was only allowed axial rotation. On the first day after the operation, the patient was allowed to get out of bed under the protection of brace.

All cases were performed by the same surgeon. The data of VAS pain scores before operation, the first day after operation and during the follow-up were carefully recorded.

Statistical Analysis

Clinical results were analyzed by the SPSS software (version 23; IBM Corp, Armonk, NY). Data were used to obtain the arithmetic mean and standard deviation values, and repeated measures analysis of variance was used for statistical analysis. A *P* value less than 0.05 was considered statistically significant.

Results

Demographic Data and Surgical Conditions

The procedure was performed on 13 patients (3 patients with intercostal neuralgia after Herpes Zoster,

Fig. 5. *The intercostal nerve was severed under direct vision.* → *show the stump of intercostal nerve.*

2 patients with intercostal neuralgia after thoracotomy, 2 patients with intercostal neuralgia after rib fracture, and 6 patients with intercostal neuralgia after vertebroplasty for compression fracture of thoracic spine), including 5 men and 8 women. All patients were between the ages of 49 to 75 years, with an average of 63.85 ± 2.46 years. In the included cases, 2 cases had 3 intercostal nerves transected, one case had 2 nerves transected, and 10 cases had one intercostal nerve transected (Table 1).

All patients had successful operations. The average operation time was approximately 31.54 ± 8.68 minutes. The average hospital stay was 4.46 ± 0.66 days.

Clinical Outcomes

The average VAS score was 1.23 ± 0.23 and 0.15 ± 0.10 on postoperative day one (POD1) and the last follow-up respectively, which was significantly lower than the average preoperative VAS of 8.46 ± 0.29 ($P < 0.001$) (Table 1). No recurrence of intercostal neuralgia was reported.

Table 1. *Patient demographics, procedures, and preoperative and postoperative pain score details.*

Pt. No.	Gender	Age (Years)	Cause of Intercostal Neuralgia	Duration of Pain (Months)	Intercostal Nerves Severed	VAS		
						Preop	POD1	The Last Follow-up
1	Man	67	PHN	10	R 8th, 9th, 10th	9	3	1
2	Woman	73	Thoracic osteoporotic compression fracture	4	R 11th	10	1	0
3	Woman	56	Thoracotomy	6	L 8th	8	1	0
4	Man	49	Rib fracture	7	R 10th	7	2	0
5	Woman	71	PHN	9	R 9th, 10th, 11th	8	1	0
6	Man	53	Rib fracture	5	R 9th	7	0	0
7	Man	52	Thoracotomy	13	L 6th and 7th	7	1	0
8	Woman	68	Thoracic osteoporotic compression fracture	5	R 11th	9	1	0
9	Woman	59	Thoracic osteoporotic compression fracture	3	L 10th	10	1	0
10	Woman	66	PHN	6	R 8th	9	2	1
11	Woman	72	Thoracic osteoporotic compression fracture	8	R 12th	9	2	0
12	Woman	69	Thoracic osteoporotic compression fracture	6	L 10th	8	0	0
13	Man	75	Thoracic osteoporotic compression fracture	4	L 9th	9	1	0
Overall		63.85 ± 2.46		6.62 ± 0.77		8.46 ± 0.29▲*	1.23 ± 0.23 ▲*	0.15 ± 0.10 ▲△

△$P < 0.001$, *$P < 0.001$, ▲$P < 0.001$,
Pt., patient; No., number; Postop, postoperative; POD1, postoperative day 1; VAS, visual analog scale

Complications

One patient had some degree of burning sensation in the skin along intercostal nerve distribution area on the same day of operation. This discomfort, as well as the radiating pain of intercostal nerve were both relieved on the first day after operation. No intraoperative or postoperative disturbance in respiration was reported. No hematoma or infection was reported.

Typical Cases

A 73-year-old woman complained of pain in thoracic, back, and right hypochondriac for 4 months. Patient's pain was aggravated when turning over, lying up, or having other changes of the body position. A fresh vertebral body compression fracture at T11 was taken into consideration according to the imaging examination. After the percutaneous kyphoplasty (PKP) surgery,the patient reported pain relief in thoracic and back, but continued to have pain in right hypochondriac. And no obvious relief after oral administration of non-steroidal anti-inflammatory drug. Subsequently, the intercostal nerve block at the right of T11-12 was performed and the pain was significantly relieved, but recurred in the same place one day later. CT showed bony stenosis in the right foramen of T11-12 (Fig. 6). Therefore, the symptoms were finally relieved after the procedure of percutaneous endoscopic intercostal neurectomy.

Fig. 6. *CT sagittal reconstruction image demonstrating the bony stenosis in the right foramen of T11-12.*

Discussion

Refractory intercostal neuralgia has a long course, is difficult to treat, and it is easy to relapse, so it is important to identify the cause of pain. According to our study, most patients with refractory intercostal neuralgia are elderly, especially those who have a clear history of Herpes Zoster, thoracotomy, rib, or thoracic spine fractures. For this type of patient, no traditional treatment modality has given effective pain relief. Combining with our cases, we considered the causes of the poor effect of traditional treatment may be related to the following factors:

1) PHN is a common cause of intercostal neuralgia. Two patients with rheumatoid arthritis and one patient with asthma were included in our study, all of them had been taking hormones for a long time, which caused low immunity and susceptibility to Herpes Zoster. Moreover, long-term steroid use led to decreased sensitivity to steroid therapy, which may have caused a certain rate of failure in the efficacy of selective nerve root injections such as for paravertebral or intercostal nerve blocks.
2) Patients with a history of thoracotomy incurred intercostal neuralgia after operation, which may be related to direct destruction of the intercostal nerve during the operation, or nerve compression caused by scar formation.
3) Intercostal neuralgia is a common complication of compression fracture of thoracic vertebrae caused by osteoporosis. Six patients still suffer from intercostal neuralgia after PKP surgery for osteoporotic fracture of thoracic vertebrae. CT scans shows that there was a narrow pathological basis in the foramina of the corresponding nerves, which indicated that PKP surgery could not effectively restore the foramina space and relieve the compression of intercostal nerves by ligaments.
4) Two patients of intercostal neuralgia after rib fracture were considered to have been caused by nerve compression, which was caused by scar formation during fracture recovery. Because of the existence of different degrees of nerve compression or injury, the traditional treatment methods, including oral neurotrophic drugs, acupuncture, physiother-

apy, and nerve block, always led to a poor result. So, patients with refractory intercostal neuralgia often need a long treatment cycle. Once patient's lack confidence in the treatment effect, it is easy to cause chronic pain. When patients suffer from chronic pain, they tend to experience some psychological changes, such as irritability, depression, pessimism (15,16), body dysfunction, decreased immunity, and various other complications, which may increase the incidence of malignant diseases, as well as cardiovascular accidents (17), resulting in huge losses of society (18).

Based on the above considerations for refractory intercostal neuralgia, an effective treatment is desirable. There have been several more reports of endoscopic surgery for thoracic and lumbar spinal decompression and discectomy that have achieved good results (19-22). Presented here is the first study to suggest endoscopic intercostal neurotomy for refractory intercostal neuralgia. Endoscopic intercostal neurotomy has the advantages of less tissue trauma and patient pain, due to the minimally invasive nature of the approach and instrumentation, as well as achieving accurate location by double confirmation during operation, which includes direct vision during operation and reconfirmation of the target nerve root by local stimulation. Although the precise intraoperative stimulation of the target nerve still requires the patient's cooperation in order to determine whether the symptoms are consistent with the preoperative one, compared with x-ray or CT-guided radiofrequency therapy, patients don't need repeated feedback. Furthermore, surgical neurectomy under direct vision can avoid the difficulty of determining the degree and scope of nerve excision when under the guidance of x-ray or CT, so as to transect the target nerve completely and to ensure the effectiveness of the surgery. Among the 13 patients enrolled in the present study, significant pain relief was reported on day one postoperatively and there was no recurrence of intercostal neuralgia upon the last follow-up, showing a definite curative effect.

According to anatomical studies (23), the thoracic spinal nerve divides into a large ventral and small dorsal ramus after exiting through the intervertebral foramen, the former of which becomes the intercostal nerve. The dorsal root ganglion (DRG) normally lies in the medial intervertebral foramen, with the confluence of the dorsal and ventral roots lying just distal to this point. Approach to the lateral thoracic spine is limited by the rib head, so the endoscope was put into the lower part of the intervertebral foramen, so, the target intercostal nerve which is the exiting root in the intervertebral foramen just distal to DRG was clearly visible under the endoscopy.

Intercostal nerves participate in thoracic breathing. Engel (24) found that no more than 3 destroyed intercostal nerves had no significant effect on respiratory function. Kang et al (2) also used alcohol for intercostal neuralgia. In this study, 3 intercostal nerves were destroyed in 19 patients and 2 were destroyed in 11 patients. All the patients were operated on successfully with no complication. In our study, 2 cases had 3 intercostal nerves transected, one case had 2 intercostal nerves transected, and the rest had only one nerve transected. Complications, such as aspiration dysfunction were not found. One patient reported the obvious burning sensation of skin along intercostal nerve distribution area, which disappeared the first day after operation without interference. Larger numbers of patients and a prospective longitudinal study would help further define the reason.

Conclusion

Endoscopic intercostal neurotomy presented here as a possible, effective and safe, minimally-invasive treatment for refractory intercostal neuralgia. It is noted that this is a small retrospective case series and a larger case series with longer term follow-up is needed.

References

1. Bajwa ZH, Sami N, Warfield CA, et al. Topiramate relieves refractory intercostal neuralgia. *Neurology* 1999; 52:1917.
2. Kang J, Liu Y, Niu L, et al. Anesthesia upstream of the alcoholic lesion point alleviates the pain of alcohol neurolysis for intercostal neuralgia: A prospective randomized clinical trial. *Clinics (Sao Paulo)* 2020; 75:e1296.
3. Zwölfer W, Hartmann T, Spacek A, et al. Ten years of therapy resistant intercostal neuralgia-suspected postherpetic neuralgia following herpes zoster sine herpete. *Schmerz* 1993; 7:182-184.
4. Britt T, Sturm R, Ricardi R, et al. Comparative evaluation of continuous intercostal nerve block or epidural analgesia on the rate of respiratory complications, intensive care unit, and hospital stay following traumatic rib fractures: A retrospective review. *Local Reg Anesth* 2015; 8:79-84.
5. Lee HJ, Park HS, Moon HI, et al. Effect of ultrasound-guided intercostal nerve block versus fluoroscopy-guided epidural nerve block in patients with

thoracic herpes zoster: A comparative study. *J Ultrasound Med* 2019; 38:725-731.

6. Abd-Elsayed A, Lee S, Jackson M. Radiofrequency ablation for treating resistant intercostal neuralgia. *Ochsner J* 2018; 18:91-93.
7. Williams EH, Williams CG, Rosson GD, et al. Neurectomy for treatment of intercostal neuralgia. *Ann Thorac Surg* 2008; 85:1766-1770.
8. Ducic I, Larson EE. Outcomes of surgical treatment for chronic postoperative breast and abdominal pain attributed to the intercostal nerve. *J Am Coll Surg* 2006; 203:304-310.
9. Wong L. Intercostal neuromas: A treatable cause of postoperative breast surgery pain. *Ann Plast Surg* 2001; 46:481-484.
10. Kastler A, Aubry S, Sailley N, et al. CT-guided stellate ganglion blockade vs radiofrequency neurolysis in the management of refractory type I complex regional pain syndrome of the upper limb. *Eur Radiol* 2013; 23:1316-1322.
11. Ali Eissa AA, Reyad RM, Saleh EG, et al. The efficacy and safety of combined pulsed and conventional radiofrequency treatment of refractory cases of idiopathic trigeminal neuralgia: A retrospective study. *J Anesth* 2015; 29:728-733.
12. Racz GB, Ruiz-Lopez R. Radiofrequency procedures. *Pain Pract* 2006; 6:46-50.
13. Makharita MY, El Bendary HM, Sonbul ZM, et al. Ultrasound-guided pulsed radiofrequency in the management of thoracic postherpetic neuralgia: A randomized, double-blinded, controlled trial. *Clin J Pain* 2018; 34:1017-1024.
14. Akkaya T, Ozkan D. Ultrasound-guided pulsed radiofrequency treatment of the intercostal nerve: Three cases. *J Anesth* 2013; 27:968-969.
15. Asmundson GJ, Katz J. Understanding the co-occurrence of anxiety disorders and chronic pain: State-of-the-art. *Depress Anxiety* 2009; 26:888-901.
16. Hooten WM. Chronic pain and mental health disorders: Shared neural mechanisms, epidemiology, and treatment. *Mayo Clin Proc* 2016; 91:955-970.
17. Lolay GA, Abdel-Latif AK. Trauma induced myocardial infarction. *International Journal of Cardiology* 2016; 203:19-21.
18. Gatchel RJ. A biopsychosocial overview of pretreatment screening of patients with pain. *Clin J Pain* 2001; 17:192-199.
19. Li W, Gao S, Zhang L, et al. Full-endoscopic decompression for thoracic ossification of ligamentum flavum: surgical techniques and clinical outcomes: A retrospective clinical study. *Medicine* 2020; 99:e22997.
20. Shen J, Telfeian AE. Fully Endoscopic 360° decompression surgery for thoracic spinal stenosis: Technical note and report of 8 cases. *Pain Physician* 2020; 23:E659-E663.
21. Telfeian AE, Iprenburg M, Wagner R. Endoscopic spine surgery: Distance patients will travel for minimally invasive spine surgery. *Pain Physician* 2017; 20:E145-E149.
22. Liu C, Chu L, Yong HC, et al. Percutaneous endoscopic lumbar discectomy for highly migrated lumbar disc herniation. *Pain Physician* 2017; 20:E75-E84.
23. Shamji MF, Sundaresan S, Da Silva V, et al. Subarachnoid-pleural fistula: Applied anatomy of the thoracic spinal nerve root. *ISRN Surg* 2011; 2011:168959.
24. Engel AJ. Utility of intercostal nerve conventional thermal radiofrequency ablations in the injured worker after blunt trauma. *Pain Physician* 2012; 15:E711-E718.