Ultrasound-guided Pulsed Radiofrequency Lesioning of the Phrenic Nerve in a Patient with Intractable Hiccup

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Persistent and intractable hiccups (with respective durations of more than 48 hours and 1 month) can result in depression, fatigue, impaired sleep, dehydration, weight loss, malnutrition, and aspiration syndromes. The conventional treatments for hiccups are either non-pharmacological, pharmacological or a nerve block treatment. Pulsed radiofrequency lesioning (PRFL) has been proposed for the modulation of the excited nervous system pathway of pain as a safe and nondestructive treatment method. As placement of the electrode in close proximity to the targeted nerve is very important for the success of PRFL, ultrasound appears to be well suited for this technique. A 74-year-old man suffering from intractable hiccups that had developed after a coronary artery bypass graft and had continued for 7 years was referred to our pain clinic. He had not been treated with conventional methods or medications. We performed PRFL of the phrenic nerve guided by ultrasound and the hiccups disappeared. (Korean J Pain 2010; 23: 198-201)

Key Words:
hiacup, pulsed radiofrequency, ultrasound.
sound as an initial RF treatment, they can assess the anatomo-
tical structures as preparation for the treatment of tar-
geted nerves [6]. Herein, as we succeeded in eliminating
intractable hiccups through PRFL guided by ultrasound, we
report the case with reviewing the related literature.

CASE REPORT

Our patient was a 74-year-old man who had received
dialysis for 8 years due to end-stage renal disease. His
hiccups started 1 year after the beginning of dialysis and
occurred 2–3 times per week, typically lasting 1–2 hours
each time. A magnetic resonance image (MRI) scan of his
brain did not detect any problems, apart from a lacunar
infarct of the central pontine. He was treated with drugs
in the department of internal medicine with no apparent
improvement in symptoms. The patient had undergone
coronary artery bypass graft surgery 6 years earlier due
to myocardial infarction; subsequently, his hiccups wors-
ened, appearing very frequently, especially when he fin-
ished eating in the afternoon or tried to sleep at night.
He usually suffered 3–4 hours once the hiccups started.
To treat his aggravated symptoms, 5 mg of baclofen and
100 mg of gabapentin were given twice a day, making him
somewhat better. However, he was not able to increase the
dose, as he showed symptoms of drowsiness and ataxia
at a higher dose. Eventually, the patient was referred to
our pain clinic, complaining of fatigue, insomnia, and
weight loss.

Our first action for the patient was blocking the right
phrenic nerve guided by ultrasound using 4 ml of 0.2% ro-
pivacaine and 10 mg of triamcinolone (Fig. 1). This proce-
dure decreased the frequency of the hiccups for about one
week, but afterward, his symptoms returned to their pre-
vious state. Three weeks later, we attempted to perform
the same procedure on the left phrenic nerve, only to have
the same outcome: a relapse after approximately 1 week.

Consequently, we decided to perform PRFL, targeting
both phrenic nerves with the use of ultrasound. After ex-
plaining the procedure, efficacy and possible side effects
of the pulsed RF treatment, we put the patient in a supine
position and turned his face to the left in order to perform
the procedure, aiming at the right phrenic nerve. We prep-
pped the skin above with betadine and aseptically draped
and placed a 10 MHz, linear probe at a position 2 cm cepha-
dal from the top of the clavicle to observe the anatomical
structures of his neck through ultrasound (Xario, Toshiba,
USA). After discovering the phrenic nerves situated in the
middle, anterior margin of anterior scalene (Fig. 2), the 10
cm RF electrode (Neurotherm, Medipoint, Germany) with a
5 mm active tip was advanced as close as possible to the
nerves by using the ultrasound. Nerve stimulation using
the RF lesion generator (Neurotherm, Morgan Automat-
ion LTD, UK) showed concordant movement of 120 times
per minutes in upper abdomen at 2 Hz and 0.5 mA which
confirmed proper localization of the RF electrode. After
clarifying the location of the target nerves once again, we
performed PRFL twice for a total of 120 seconds at 42°C
and at stimulation intervals of 20 ms/sec. Following this
procedure, the same method was applied to the left phrenic
nerve.

Throughout the treatment, the patient did not show

Fig. 1. Ultrasound image of needle tip which is adjacent to
phrenic nerve for nerve block.

Fig. 2. Ultrasound image of patient's phrenic nerve and
related structures for pulsed radiofrequency lesioning.
Our patients slightly responded to baclofen and gabapentin, but all other drugs were not effective. The authors reported previously that baclofen could cause neurotoxicity to renal disease patients even with a small amount [14]. For this reason, we were not able to increase the dose of baclofen because the patient had uremia developed in the end-stage renal disease. Also, in the case of gabapentin, he showed the symptoms of drowsiness and ataxia, which made it hard for him to lead a normal life, so that he had to stop taking the drug. Furthermore, the effect of phrenic nerve block using local anesthetics remained only for a week. After all, we decided to perform PRFL.

The phrenic nerve commands the movement of a diaphragm and provides the sensory innervation of the middle of a diaphragm, some parts of the pleura and pericardium. The phrenic nerve originates mainly from the 4th cervical nerve, but also receives contributions from the 3rd and 5th cervical nerves (C3–C5) in humans. Those three nerves join at the upper, lateral portion of the anterior scalene, forming phrenic nerves. The nerve descends obliquely across the anterior scalene, through the gap between sternocleidomastoid and omohyoid muscles, and deep into the thorax. According to the recent anatomical study of the phrenic nerve by using ultrasound, it is oval and its average diameter is 0.6 × 1.0 mm (ranging from 0.3 × 0.6 to 0.8 × 1.7) whether left or right side. Moreover, there is no significant difference in this nerve between among genders and ages [15].

Nerve block guided by ultrasound is known to be safer than the one solely depending on surface anatomy. The reason is that operators can identify the anatomical structures of nerves, muscles and blood vessels in real time while approaching a needle to target nerves. In other words, operators don’t have to depend only on surface anatomy anymore and nerve or blood vessel damage can be prevented [6]. We thought that ultrasound was necessary not only for nerve block but also for PRFL since a RF catheter should be placed as close as possible to target nerves. In our case, we found his phrenic nerve so easily that he showed the symptoms of drowsiness and ataxia, which made it hard for him to lead a normal life, so that he had to stop taking the drug. Furthermore, the effect of phrenic nerve block using local anesthetics remained only for a week. After all, we decided to perform PRFL.

The mechanism of PRFL is based to inhibit evoked synaptic activity of excitatory C-fiber in response to repetitive, burst-like stimulation of A δ-fiber and to change structure of nerve tissue [16]. The conventional heat-based RF is programmed to remove pain-causing nerve with heat...
as high as 60–80°C. Accordingly, it inevitably gives damage to surrounding nerve tissues although it can relieve pain in the long time. However, PRFL can minimize nerve damage since mechanism of PRFL is neuromodulation of electromagnetic fields generated by electric current [4]. Amidst recently-growing use of PRFL in peripheral nerve disorders, Philip et al. [17] reported a case that a patient with meralgia paresthetica was completely cured after receiving a round of PRFL at his lateral femoral cutaneous nerve without any side effect accompanied. Also, Liliang et al. [18] reported a case of PRFL applied for 11 patients who suffer from chronic shoulder pain, targeting their suprascapular nerves, and confirmed that the effect of pain relief lasted longer than 6 months.

In conclusion, through this case report, we illustrated our experience of performing PRFL of phrenic nerve, which is safer and more accurate treatment, with the guidance of ultrasound. We attempted to present the possible effectiveness of PRFL against the intractable hiccups that are not responsive to other types of treatments including pharmacological treatment. Last but not least, we believe that, for PRFL to be used widely in this way, further studies will be needed to prove the safety and efficacy of the treatment, getting more patients involved.

REFERENCES

1. Homer JR, Davies JM, Amundsen LB. Persistent hiccups after attempted interscalene brachial plexus block. Reg Anesth Pain Med 2005; 30: 574–6.
2. Cymet TC. Retrospective analysis of hiccups in patients at a community hospital from 1995–2000. J Natl Med Assoc 2002; 94: 480–3.
3. Pooran N, Lee D, Sideridis K. Protracted hiccups due to severe erosive esophagitis: a case series. J Clin Gastroenterol 2006; 40: 183–5.
4. Cosman ER Jr, Cosman ER Sr. Electric and thermal field effects in tissue around radiofrequency electrodes. Pain Med 2005: 6: 405–24.
5. Nguyen M, Wilkes D. Pulsed radiofrequency V2 treatment and intranasal sphenopalatine ganglion block: a combination therapy for atypical trigeminal neuralgia. Pain Pract 2010: 10: 370–4.
6. Brull R, Perlas A, Cheng PH, Chan VW. Minimizing the risk of intravascular injection during ultrasound-guided peripheral nerve blockade. Anesthesiology 2008: 109: 1142.
7. McFarling DA, Susac JO. Hoquet diabolique: intractable hiccups as a manifestation of multiple sclerosis. Neurology 1979; 29: 797–801.
8. Marshall JB, Landreneau RJ, Beyer KL. Hiccups: esophageal manometric features and relationship to gastroesophageal reflux. Am J Gastroenterol 1990: 85: 1172–5.
9. Kahrilas PJ, Shi G. Why do we hiccup? Gastroenterology 1997; 112: 712–3.
10. Lee JH, Kim TY, Lee HW, Choi YS, Moon SY, Cheong YK. Treatment of intractable hiccups with an oral agent monotherapy of baclofen: a case report. Korean J Pain 2010; 23: 42–5.
11. Tegeler ML, Baumrucker SJ. Gabapentin for intractable hiccups in palliative care. Am J Hosp Palliat Care 2008; 25: 52–4.
12. Babacan A, Oztürk E, Kaya K. Relief of chronic refractory hiccups with glossopharyngeal nerve block. Anesth Analg 1998; 87: 980.
13. Calvo E, Fernández-La Torre F, Brugarolas A. Cervical phrenic nerve block for intractable hiccups in cancer patients. J Natl Cancer Inst 2002; 94: 1175–6.
14. Chou CL, Chen CA, Lin SH, Huang HH. Baclofen-induced neurotoxicity in chronic renal failure patients with intractable hiccups. South Med J 2006; 99: 1308–9.
15. Canella C, Demondion X, Delebarre A, Moraux A, Colton H, Colton A. Anatomical study of phrenic nerve using ultrasound. Eur Radiol 2010; 20: 659–65.
16. Cahana A, Vutskits L, Muller D. Acute differential modulation of synaptic transmission and cell survival during exposure to pulsed and continuous radiofrequency energy. J Pain 2003: 4: 197–202.
17. Philip CN, Candido KD, Joseph NJ, Crystal GJ. Successful treatment of meralgia paresthetica with pulsed radiofrequency of the lateral femoral cutaneous nerve. Pain Physician 2009; 12: 881–5.
18. Liliang PC, Lu K, Liang CL, Tsai YD, Hsieh CH, Chen HJ. Pulsed radiofrequency lesioning of the suprascapular nerve for chronic shoulder pain: a preliminary report. Pain Med 2009; 10: 70–5.