



Using Low-Temperature Plasma Radiofrequency Ablation in the Treatment of an Intractable Hiccup: A Case Report

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Abstract

Intractable hiccups are triggered by many factors, and current treatment options are often ineffective. Low-temperature plasma radiofrequency ablation, as a minimally invasive surgery, is an effective method for the treatment of some neurogenic cervical spondylosis. The report describes a 64-year-old patient with intractable hiccups who had been hospitalized for 2 months without satisfactory results from medication. MR examination and anterior cervical radiography revealed that the patient's hiccups were caused by a protruding nucleus pulposus causing nerve root compression. Therefore, a low-temperature plasma radiofrequency ablation treatment was administered to the patient. Following treatment for 3 days, the patient was discharged with significant relief from the symptoms associated with hiccups. After one month of treatment, the frequency of hiccups was reduced significantly and only appeared on occasion. A new treatment for this intractable hiccup caused by nerve compression is presented here, and more cases are needed to prove its effectiveness.

Keywords: Intractable hiccup; Low-temperature plasma radiofrequency ablation; Nerve root type cervical spondylosis; Diaphragm muscle; Phrenic nerve

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Introduction

Modern medicine refers to hiccups as diaphragmatic spasms. A hiccup is a short, loud sound produced by an involuntary spasmodic contraction of the diaphragm, the rapid passage of outside air into the lungs, the emergency closure of the vocal chambers, and the vibration of the vocal cords [1-3]. The most common cause of physiological hiccups is eating too much, too fast, or too hot or too cold. Physiological hiccups are usually transient and can be relieved by themselves. It has been determined that pathological hiccups are primarily associated with cerebrovascular disease, post-radiotherapy of tumors, gastrointestinal dysfunction, and increased intra-abdominal pressure, involving the nervous system, respiratory system, digestive system, drugs, and psychological factors [4,5]. Most cases of hiccups last only a short time, typically less than 48 h. A few cases of hiccups may last for days, months, or even years. Hiccups that persist for more than 48 h are termed persistent hiccups, and those that persist for more than 30 days are termed intractable hiccups [6]. As a result of intractable hiccups, patients may experience difficulties eating and mental depression, aggravating the primary disease, which then leads to sleep disorders, anxiety, and depression, which in turn reduces the quality of their lives [7-9]. Despite ongoing research, the pathogenesis of hiccups remains unclear, and there is no unified treatment plan. There are several treatment options, including medication, acupuncture, surgery, and interventional procedures. Medications are commonly prescribed for patients with intractable hiccups, such as chlorpromazine and metoclopramide. The effectiveness of these medications is still questionable, and the side effects are obvious [10]. As an adjunctive therapy, acupuncture can be used as a form of treatment, including acupuncture, moxibustion, acupuncture point injections, acupuncture point buried threads, etc. The results of several studies indicate that such approaches may be effective in treating intractable hiccups, but that they are not able to cure them [11,12]. When drug and acupuncture treatments fail to provide adequate results, surgical and interventional treatments, such as irreversible phrenic nerve disruption, and ultrasound-guided phrenic nerve block [13-17], should be selected with extreme caution, since diaphragm function should be carefully evaluated before a surgery and should be avoided in patients with partial combined respiratory insufficiency before surgery.

As described in this paper, an elderly patient with intractable hiccup symptoms was treated with cervical intervertebral disc plasma ablation for the treatment of hiccup symptoms and obtained satisfactory results following surgery.

Case Presentation

The patient, a 64-year-old male, complained that he had been suffering from hiccups for more than two months, which became more severe after one month. There was no obvious cause for the patient's hiccup two months ago, which persisted despite position changes and did not worsen, with postprandial vomiting symptoms accompanying it. There was no relief for him after he was treated in several hospitals. During the past month, his hiccup symptoms worsened, and self-medication did not work, so he sought medical care at our hospital. This patient was suffering from a malignant lung tumor for more than a year, undergoing regular chemotherapy, but not undergoing any surgical procedure.

Treatment procedure

An MR scan of the cervical spine was performed on the day of admission, suggesting cervical 3/4 - cervical 6/7-disc herniation, as well as lateral and frontal radiographs of the cervical spine which indicated cervical degeneration. The patient was provided with an ondansetron injection as a symptomatic treatment on the following day. He still suffered from frequent hiccups, nausea, and vomiting the following day. It was discussed with the family that the hiccup symptoms might be closely related to the neck, and on the third day of admission, we scheduled a cervical disc cryo-radiofrequency ablation using low-temperature plasma.

Surgical procedure

The surgeon needs the patient in a supine position and pads the patient's shoulders to hyperextend the cervical spine so that the patient's neck is fully exposed while positioning the puncture site. The surgeon disinfects the puncture site and then infiltrates local anesthetic through the trachea, esophagus, and carotid sheath space layer by layer to anesthetize the deep fascia. The surgeon separates the trachea, esophagus, and carotid sheath with the left hand and punctures the trocar needle into the C3/4 disc at 45° from the sagittal

plane with the right hand. The surgeon needs DSA to accurately locate the needle tip position, then withdraws the needle core while placing the plasma knife, and then initiates low-temperature radiofrequency ablation with a duration of 3 seconds per radiofrequency is used three times in a row to complete the C4/5 -disc puncture, as shown in Figure 1.

Following a satisfactory puncture of the C4/5 position, the same procedure was followed for RF, with the patient experiencing no pain or numbness in the extremities. During the procedure, the anesthetic effect was satisfactory and the operation went smoothly. After returning to the ward, the patient received pain relief and symptomatic treatment for intraoperative bleeding.

Postoperative results

During the first day following surgery, the patient complained of a hiccup. As the postoperative edema had not subsided, methylprednisolone sodium succinate for injection was administered to reduce the postoperative neuroedema. There was still a hiccup on the second day following surgery, but the patient's symptoms had significantly diminished. On the third postoperative day, the patient still complained of a hiccup, a condition that significantly improved over the preoperative period. After seven days postoperatively, the patient revealed significant relief from hiccup symptoms and no nausea or vomiting. In the postoperative month, the patient experienced occasional hiccups that resolved on their own.

Discussion

The etiology of intractable hiccups is intricate and often has multiple causes in combination (Table 1). When the cause of the hiccups is found early and treated symptomatically, patients are often able to greatly improve their symptoms and quality of life. A Proton Pump Inhibitor (PPI) is the first-choice medication for intractable hiccups caused by gastroesophageal reflux, and often the symptoms are significantly improved. In the case of intractable hiccups of

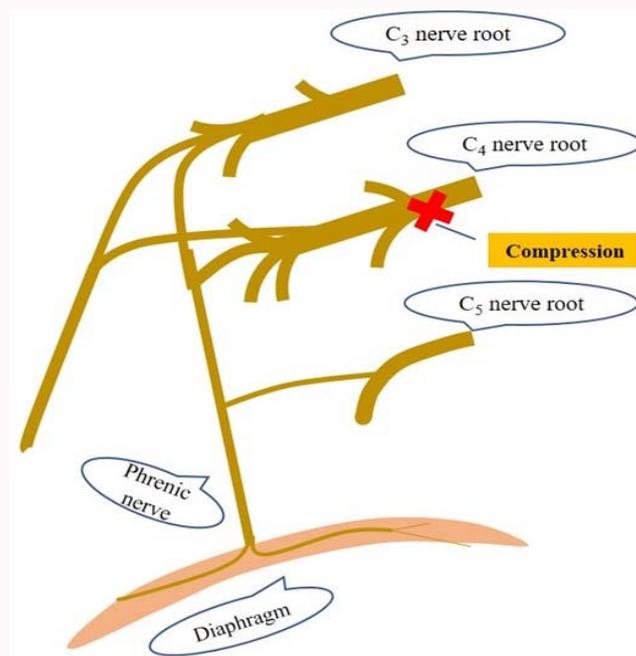


Figure 1: The protruding nucleus pulposus was compressing the C4 nerve root, causing long-term irritation of the downstream phrenic nerve and causing involuntary spasmodic contractions of the diaphragm. The nucleus pulposus resection relieved the nerve compression, allowing the nerve function to slowly recover and the hiccup symptoms to be relieved as a result.

Table 1: Causes of hiccups.

Central Nervous System	Cerebellar tumors, midbrain tumors, Stroke, Traumatic brain injury
Peripheral Nervous System	Toxic goiter, arteriovenous tumor, tracheal and esophageal lesions in the neck; pleurisy, lymphoma, mediastinal compression in the chest; subdiaphragmatic abscess, gastrointestinal distension, gastric cancer in the abdomen
Systemic metabolic diseases	Electrolyte disorders, uremia, hepatic encephalopathy
Medical causes	Tumor radiotherapy, abdominal or mediastinal surgery, sulfonamides, dexamethasone
Other factors	Associated with psychological and dietary factors, including the intake of tobacco, alcohol, and tea

unknown etiology, PPI may be used as the first empirical therapy even if there are no symptoms such as acid reflux and heartburn. An effector of the phrenic nerve innervates the diaphragm, which causes hiccups.

It is primarily composed of the ventral branches of the 4th cervical nerve, which originate from the ventral branches of the 3rd through 5th cervical nerves. As it travels along its course, the phrenic nerve receives branches from the paramedian nerve and the hypoglossal nerve. Main branches of the phrenic nerve branch from the anterior oblique muscle, which converge into the main trunk of the phrenic nerve. They may also descend into the thorax for convergence into the main trunk. In the phrenic nerve, there are both motor and sensory fibers, mainly somatomotor fibers, and the left phrenic nerve is longer than the right phrenic nerve, both of which innervate the same side of the diaphragm [18,19]. As the phrenic nerve plays a crucial role in maintaining normal ventilatory function, loss of function will result in decreased ventilatory function, which in turn will affect respiratory function.

Hiccups are caused by a reflex arc. An afferent nerve fiber, located between T6 and T12, includes the vagus nerve, phrenic nerve, or sympathetic nerve fibers, while the reflex center consists of the upper spinal cord, medullary respiratory center, brainstem reticular formation, and hypothalamus. Generally, the diaphragm contracts unilaterally, frequently on the left side, and occasionally bilaterally, and the efferent nerve is the phrenic nerve [3,12,15]. Inflammation, trauma, tumors, ischemia and other factors that cause nerve jamming may result in hiccups, as may change in the electrophysiological and chemical properties of this reflex arc. Inflammation, trauma, tumor, ischemia, and metabolic factors may cause changes in the surrounding internal environment that may lead to hiccups. This patient's long duration and frequent attacks of hiccups are most likely caused by a herniated C3/4 disc in the cervical spine. As a result of nerve entrapment, the herniated nucleus pulposus compresses the nerve roots, causing neuroinflammation and increased excitability, resulting in long-term stimulation of the downstream nerves, the phrenic nerves, resulting in involuntary spasmodic contractions of the diaphragm, causing the occurrence of hiccups.

In the field of otolaryngology and head and neck surgery, low-temperature plasma radiofrequency ablation has proven to be an efficient and effective minimally invasive technique [20,21]. In cases of mild neurogenic cervical spondylosis, its efficacy can produce excellent results [22]. Based on the principle of low-temperature plasma ablation, this procedure utilizes conventional discography methods to directly vaporize the nucleus pulposus tissue at a lower temperature, resulting in a minimally invasive and relatively safe process of decompression and disc shaping. As a result of this technique, the tissue can be removed at a lower temperature (40°C to 70°C), preventing thermal damage to the surrounding tissues and allowing hemostasis and suction to occur in a shorter timeframe than with laser and electric knives (400°C). A temperature of 60 degrees

Celsius can reduce the target tissue volume and close the microvessels within the target tissue, reducing intraoperative bleeding. By using low-temperature plasma radiofrequency ablation, the herniated nucleus pulposus on one side was vaporized and excised, alleviating the nerve compression caused by the herniated nucleus pulposus and relieving long-term irritation of the phrenic nerve, thus alleviating hiccup symptoms. Nonetheless, nerve function takes a very long time to recover, so patients will continue to experience hiccup symptoms after discharge from the hospital. As the nerve function is fully restored, the symptoms of hiccups may eventually disappear.

It appears that the current treatment for hiccups is anachronistic for this patient. Drug therapy should not be effective, and side effects remain a significant obstacle to its use. Although acupuncture can alleviate the symptoms, it does not treat the underlying cause, and hiccups can still occur frequently and the treatment process may make the patient feel uncomfortable. In such elderly patients, phrenic nerve block and disruption are also inadvisable. Generally, these procedures affect a patient's respiratory function more severely, and the impact of such procedures on a patient's respiratory function should be evaluated promptly, as there is a certain risk of block failure. For the patient, low-temperature plasma radiofrequency ablation is the most appropriate treatment because it relieves the symptoms of hiccups once and for all by eliminating the cause of the hiccups and reducing the risks associated with other treatments, leading to improved patient comfort and quality of life.

The etiology of intractable hiccups is diverse and often consists of a combination of factors. There is evidence to support the efficacy of low-temperature plasma radiofrequency ablation as a method of treating intractable hiccups resulting from cervical spine pathology, and it has obvious advantages over other treatment methods. However, clinical studies are lacking to support its efficacy and prognosis, and a large number of clinical cases are required to verify its effectiveness.

Author Contributions

Kang Kang Chen prepared and wrote the article. Zhiyu Zhang, Yijia Zhang, and Sihan E participated in the management of the patients. Zhiyu Zhang prepared the pictures and tables. Yingxia Liang revised the manuscript and acted as the corresponding author. All authors contributed to the article and approved the submitted version.

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