Percutaneous Procedures for the Treatment of Trigeminal Neuralgia

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KEYWORDS

• Trigeminal neuralgia • Rhizotomy • Treatment

KEY POINTS

- Percutaneous procedures are safe and effective options for the management of trigeminal neuralgia.
- The best outcomes are seen after careful patient selection and counseling.
- An individualized treatment plan for each patient is essential for maximizing pain relief.

INTRODUCTION

Three types of percutaneous rhizotomy are currently used to treat trigeminal neuralgia (TN). Percutaneous balloon compression (PBC), glycerol rhizotomy (GR), and radiofrequency thermocoagulation (RFT) are all designed to interrupt afferent pain fibers by causing injury to the trigeminal nerve root or ganglion. Conceived in the early 20th century, several decades of experience with these relatively simple techniques have demonstrated their efficacy in offering immediate and durable pain relief, as well as overall safety.[1] Although microvascular decompression (MVD) has gained in popularity and the use of percutaneous rhizotomy has been on the decline,[2] these percutaneous techniques offer several important advantages. Partial sensory rhizotomy, an open procedure that can be performed if no vascular nerve compression is found during MVD, is not discussed in this paper.

HISTORY AND CONCEPTION

The first description of TN as a distinct disease entity dates back to 1688, by Fehr and Schmidt. More than a century later, the painful syndrome was localized to the trigeminal nerve, and eventually given the name that it bears today.[3] At the time, despite an intimate knowledge of the anatomy of the trigeminal nerve and ganglion, the pathophysiology of the disease was poorly understood. The first attempted treatment of TN occurred in 1910, when Harris injected the trigeminal ganglion with alcohol. Shortly afterward, in 1914, Hartel described a method for accessing the foramen ovale for percutaneous injections still in use today.[4,5] Only 2 years after Harris described his approach, Rethi attempted to treat TN by electrocoagulation of the trigeminal nerve and ganglion. Owing to limitations in electrode design, the procedure was associated with high complication rates as a result of unintended injury to the trigeminal nerve and surrounding structures.[3] Decades passed before Sweet and Wepsic, in 1974, described RFT of the trigeminal rootlets. With the use of short-acting anesthetic agents to allow for electrical stimulation and temperature monitoring, their method allowed for precise lesion creation.[6] Over the next few decades, Nugent further refined the technique with the use of a fine cordotomy-type electrode, and Tew and Taha

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introduced curved thermistor-tipped electrodes, achieving high rates of pain relief with lower complication rates.[7,8]

The origins of GR date back to the late 19th century, when physicians injected various agents, including chloroform and osmic acid, next to nerve trunks with the goal of causing chemoneurolysis. Although reports indicate that this method was effective in producing pain relief, the effect was transient and often accompanied by significant weakness, sensory loss, and dysesthesias.[3] GR as it is exists today was developed somewhat serendipitously in 1981, when Hakanson and colleagues[9] were exploring the use of stereotactic radiotherapy as a treatment method for TN.[10,11] Glycerol, as a trivalent alcohol naturally present in human tissue, was used as the vehicle to suspend tantalum dust, and injected into the trigeminal cistern.[12] They found that injection of the carrier alone caused pain relief. Although it is thought that GR preferentially injures large myelinated fibers, the exact mechanism of action of glycerol is incompletely understood. Studies have suggested its hypertonicity, and more specifically, a rapid rate of change of intracellular osmolarity upon glycerol injection, results in axonal demyelination and fragmentation.[13–16] Although the procedure has been modified and updated in many ways, the core elements of the technique remains true to Hakanson's original method.

Balloon compression as a treatment for TN was discovered in the 1950s during investigations into scar tissue compressing the trigeminal nerve root or ganglion in the middle fossa as a cause of TN. In 1952, Taarnhøj described his method of decompression of the dorsal root of the trigeminal root, and Shelden and Pudenz reported a method for decompression of the second and third nerve divisions.[17,18] In working to decompress the trigeminal ganglion, they and others concluded that the effectiveness of their techniques in producing pain relief derived from the resultant injury to the posterior trigeminal root posterior to the ganglion. However, Shelden and colleagues[18] found that rubbing the posterior root was able to yield only transient pain relief. It was not until 1983, when Mullan and Lichtor[19] described compression of the trigeminal ganglion with a percutaneously inserted Fogarty balloon catheter, that trigeminal compression became a viable treatment option. Later studies in rabbits revealed that compression seems to preferentially affect the medium and large myelinated pain fibers, sparing small fibers, which allows for recovery of motor and sensory function, and theoretically, preservation of the corneal reflex.[20]

PATIENT SELECTION AND EVALUATION

The primary indication for percutaneous trigeminal rhizotomy remains Burchiel type 1 TN, or typical TN, an idiopathic condition in which patients experience episodic sharp or shooting electrical shock-like facial pain.[21] TN is a progressive disease, and without treatment, can transform to Burchiel type 2 TN, or atypical TN. Burchiel type 2 TN is characterized by more constant pain and is associated with sensory impairment. A trial of medical therapy with anticonvulsants is typically the initial treatment for TN, but there are no standardized guidelines regarding the minimum duration of medical therapy necessary before moving to an interventional strategy. Although some reports have suggested that trials of at least 2 anticonvulsants should be performed before surgical intervention, little evidence exists to support this notion.[22,23] Many patients experience initial pain relief with medication, but later develop breakthrough pain. Indeed, some studies have shown that more than 50% of patients with TN eventually undergo surgery.[24]

Several factors should be taken into consideration when making the choice of which surgical procedure to undertake. Percutaneous procedures are thought to be well-suited for elderly patients or those with multiple medical comorbidities for whom MVD would present a greater risk, or younger patients who wish to minimize their risk of postoperative facial numbness. However, age alone is not an absolute contraindication for craniotomy, because MVD has been shown to be well tolerated in patients older than 75 years.[1] RFT is not appropriate for patients who cannot tolerate an awake procedure or who are unable to cooperate with localization. There is a greater risk of the trigeminal depressor response and hypotension and bradycardia seen with PBC, making it less appropriate for some patients with cardiovascular disease. Each procedure allows for a varying degree division-specificity, but RFT can be used for more precise lesion creation than GR and PBC. Because of the supposed fiber-selective nature of PBC, many advocate the use of PBC for isolated first-division pain.[4] The comparative efficacy of percutaneous therapies, MVD, and stereotactic radiosurgery (SRS) is discussed elsewhere in this paper.

There are several patient subgroups who exhibit divergent outcomes from patients with typical TN. Atypical facial pain can refer to the both the quality or frequency of pain, or the underlying etiology, which can be iatrogenic, owing to postherpetic neuralgia, or in association with multiple sclerosis (MS). Although it is a nonspecific term, atypical