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Practice patterns of in-hospital surgical treatment of trigeminal neuralgia from 1988 to 2010☆

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ABSTRACT

Objective: Neurosurgeons have a variety of procedures to offer when treating medically intractable trigeminal neuralgia (TN). We reviewed the national trends in procedural volume for in-hospital treatment of TN.
Methods: The Nationwide Inpatient Sample (1988–2010) provided data on patients hospitalized with a principal diagnosis of TN and a related principal procedure. We categorized principal procedures as open, other, percutaneous, or radiosurgery.
Results: We identified 13,466 relevant hospital admissions. The volume for open procedures and radiosurgery remained relatively constant, whereas percutaneous procedures decreased. Mean age of patients undergoing percutaneous and radiosurgery procedures (67.9 and 69.5 years) was higher than open and other procedures (60.4 and 63.4 years) (p-value <0.001). The mean total in-hospital inflation-adjusted charges for all four categories increased over time (p-values <0.001). The mean total in-hospital inflation-adjusted charge for radiosurgery ($37,666) was higher than open ($28,046) procedures ($p$-value <0.001).
Conclusions: Patients who undergo an open procedure to treat TN are younger than those who undergo a percutaneous or a radiosurgery procedure. The perceived risk of open surgery in older patients may drive offering percutaneous or radiosurgical procedures. In addition, the in-hospital inflation-adjusted charges for all procedures increased over time, with radiosurgery being higher than those of open procedures.

1. Introduction

Trigeminal neuralgia (TN) is a condition that is often debilitating, particularly when facial pain is refractory to medical management or medications are associated with intolerable side effects. There are a number of surgical options available to the modern neurosurgeon to treat TN [1,2]. Although initial open surgical nerve sectioning dates as far back as 1890, microvascular decompression (MVD) was not popularized until the 1960s when Jannetta expounded the theory of microvascular compression of the trigeminal nerve [3,4]. Since then, multiple large series demonstrated good surgical results with MVD [5–7]. Percutaneous techniques date back to the early 1900s, but modern forms emerged decades later. In 1974, Sweet and Wepsic introduced the percutaneous radiofrequency ablation technique, which has been subsequently modified [8]. In 1981, Hakanson described the use of percutaneous glycerol injection for chemoneurolysis [9]. In 1983, Mullan and Lichtor introduced percutaneous balloon compression of the gasserian ganglion as a mechanical method of neurolysis [10]. Finally, radiotherapy was added to the neurosurgeon's armamentarium in 1991, when Rand began treating TN patients who had failed surgical treatment with stereotactic radiosurgery (SRS) [11]. Multiple reports subsequently demonstrated good results with SRS even as primary therapy [12–17].

While multiple options to treat TN are currently utilized, there are limited data regarding national trends in procedural volume over time. In addition, the population (e.g., volume and makeup) of patients presenting with TN is changing. Initial estimates of the incidence of TN were fewer than five cases per 100,000 patient-years in Olmstead County, Minnesota from 1945 to 1984 [18]. More recent studies estimate the incidence to lie between 12.6 and 28.9

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Table 1
ICD-9-CM codes for procedures analyzed. The counts displayed include the additional criterion of principal diagnosis ICD-9-CM code 350.1 (trigeminal neuralgia).

Category	Matching records	ICD-9-CM code	Procedure
Open	2751	04.02	Division of trigeminal nerve
Open	72	04.05	Gasserian ganglionectomy
Open	6636	04.41	Decompression of trigeminal nerve root
Open total	9459		
Other	188	01.24	Other craniotomy
Other	12	01.39	Other incision of brain
Other	26	01.59	Other excision or destruction of lesion or tissue of brain
Other	–	02.99	Other operations on skull, brain, and cerebral meninges
Other	25	04.04	Other incision of cranial and peripheral nerves
Other	306	04.07	Other excision or avulsion of cranial and peripheral nerves
Other	–	04.19	Other diagnostic procedures on cranial and peripheral nerves and ganglia
Other	22	04.49	Other peripheral nerve or ganglion decompression or lysis of adhesions
Other	12	04.6	Transposition of cranial and peripheral nerves
Other	–	04.99	Other operations on cranial and peripheral nerves
Other	–	05.29	Other sympathectomy and ganglionectomy
Other total	607		
Percutaneous	1879	04.2	Destruction of cranial and peripheral nerves
Percutaneous	25	04.80	Peripheral nerve injection, not otherwise specified
Percutaneous	401	04.81	Injection of anesthetic into peripheral nerve for analgesia
Percutaneous	59	04.89	Injection of other agent, except neurolytic
Percutaneous	34	05.31	Injection of anesthetic into sympathetic nerve for analgesia
Percutaneous	–	05.32	Injection of neurolytic agent into sympathetic nerve
Percutaneous	36	05.39	Other injection into sympathetic nerve or ganglion
Percutaneous	–	83.98	Injection of locally acting therapeutic substance into other soft tissue
Percutaneous	95	99.29	Injection or infusion of other therapeutic or prophylactic substance
Percutaneous total	2544		
Radiosurgery	–	92.24	Teleradiotherapy using photons
Radiosurgery	–	92.29	Other radiotherapeutic procedure
Radiosurgery	22	92.30	Stereotactic radiosurgery, not otherwise specified
Radiosurgery	53	92.31	Single source photon radiosurgery
Radiosurgery	759	92.32	Multi-source photon radiosurgery
Radiosurgery	–	92.33	Particulate radiosurgery
Radiosurgery	13	92.39	Stereotactic radiosurgery, not elsewhere classified
Radiosurgery total	856		

Note: In compliance with HCUP data use agreement, values less than or equal to 10 are represented as –.

cases per 100,000 patient-years [19–21]. Additionally, the incidence of TN increases significantly with age. One study reported an incidence of eighty-two cases per 100,000 patient-years in those over the age of seventy-five [20]. Concomitant with an aging population, neurosurgeons now see more elderly patients with medical co-morbidities. Conflicting evidence exists on the risk of MVD with advanced age [22–26]. Age, comorbidities, and patient and practitioner preference between multiple treatment options likely play a significant role in the selection of surgical treatment of TN.

Given the changes in and evolution of treatment options over the past two decades, the increased frequency with which TN is now diagnosed, the aging of the general population, and an increased focus on treatment efficacy and cost, we reviewed the trends in overall procedural volume for the in-hospital treatment of TN from 1988 to 2010 using a national inpatient database [27–30].

2. Materials and methods

We examined national trends in the treatment of TN from 1988 to 2010 using hospital discharge data from the Nationwide Inpatient Sample (NIS), Healthcare Cost and Utilization Project (HCUP), Agency for Healthcare Research and Quality (Rockville, MD). The NIS is the largest publicly available all-payer inpatient care database of non-federal hospitals in the United States (U.S.). The NIS contains data from approximately five to eight million hospital stays each year and represents an approximately twenty-percent stratified sample of U.S. community (non-federal) hospitals. The data presented in the study are counts of the hospital admissions listed in the NIS database. When specified, the aggregate sum of estimated discharges using the discharge weight (NIS variable DISCWT) is used to provide estimates of annual U.S. volume. Corrected discharge weight data for years 1988 to 1997, as suggested and published by HCUP, are used (see http://www.hcup-us.ahrq.gov/db/nation/nis/trendwghts.jsp). Notably, the HCUP NIS data use agreement prohibits public disclosure of tabulated data where the number of observations (i.e., individual discharge records) in any given cell of tabulated data is less than or equal to ten. Correlation between comorbidities, complications, and outcomes have been presented previously and are excluded from the present analysis [5,22,31].

2.1. Inclusion criteria

Hospital admissions in the NIS were first selected for inclusion if they contained a principal diagnosis code for TN (ICD-9-CM 350.1). We reviewed the resulting list of primary procedures and categorized each as “open, other, percutaneous, or radiosurgery”; see Table 1. The “open” category represents MVD and presumed nerve root sectioning. The “other” category includes procedures appropriate for the treatment of TN but the identification of an “open” or “percutaneous” procedure is uncertain.

Fig. 1 demonstrates the total hospital admissions analyzed and the resulting number of patient hospitalizations in each category. Of 21,779 NIS records matching ICD-9-CM diagnosis code 350.1, 5180