Web-based Survey of Different Dental and Medical Practitioners on Oro-facial Pain Conditions

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THESIS

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This thesis is dedicated to my wife Sonal and son Ishaan without whose help, support and encouragement my pursuit of higher education would never have been possible.
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Summary

The management of orofacial pain is of significance to the medical and dental professions. Dentists are most likely to face this situation, because persistent and chronic pain is more common in the head and neck region than in any other part of the body. The complexities involved in diagnosing neuropathic pain present a challenge for the treating clinician. These conditions are of importance in clinical dentistry as sometimes they can be misdiagnosed as an odontogenic pain leading to unnecessary irreversible treatment including endodontic treatment and sometimes extraction. The hypothesis that there will be greater than 60% agreement in diagnostic terminology among clinicians dealing with atypical facial pain (AFP), trigeminal neuralgia (TN) and atypical odontalgia (AO) was tested. The aim of this study was to compare the views of dental and medical clinicians who deal with atypical facial pain, trigeminal neuralgia and atypical odontalgia about the terminology, diagnostic tools and treatment approach.

Electronic questionnaires with three hypothetical orofacial pain scenarios were sent to 100 healthcare professionals in each of the following groups: general dentist, endodontists, oral medicine specialists, neurologists and otolaryngologists. The e-mail addresses were collected from doctor's contact information available in the public domain over the internet. A subscription service of Qualtrics was used for the electronic survey and the data collected was analyzed using statistical software SPSS 19. The clinicians were presented with hypothetical cases atypical facial pain (AFP), trigeminal neuralgia (TN) and atypical odontalgia (AO).
The result of this study highlights inter-clinician variability in diagnosis and treatment among clinicians dealing with AFP, TN and AO. An interesting observation in the case scenario of AO was the majority of respondents chose the diagnostic terminology of AFP, although AO is an established independent clinical entity. Overall, the study also draws attention to the need for education of orofacial pain conditions both at undergraduate and postgraduate level of medical and dental education.

Patients with neuropathic pain conditions often benefit from treatment which includes both medical and dental clinicians and an interdisciplinary approach. Endodontists, orofacial pain dentists, general dentists, specialists in oral medicine, neurologists and otolaryngologists are all likely to deal with the diagnosis and management of orofacial pain conditions and a consensus in diagnostic terminology and uniformity in management is recommended.
1. INTRODUCTION

1.1 Orofacial neuropathic pain

Dentists are occasionally presented with the complex challenge of diagnosing and treating pain of a neuropathic origin in the orofacial region. Persistent and chronic pain is more common in the head and neck region than in any other part of the body (Matwychuk 2004). Chronic pain constitutes a substantial socio-economic challenge and the impact of pain on economy is significant. The complexities and diagnostic challenges suggest that misdiagnosing neuropathic pain is common, potentially resulting in unnecessary irreversible dental treatment. In contrast to transmission of stimulation in nerves in response to disease or trauma, neuropathic pain is caused by pathology affecting the nerves themselves. Orofacial neuropathic pain is chronic, diverse in quality, difficult to localize and occurs in the absence of obvious pathology. Additionally, it can be paroxysmal or continuous in nature and serves no protective function. This is in contrast to physiological pain which warns of noxious stimuli and can serve a protective function (Vickers 2000).

Neuropathic pain results from damage to or dysfunction of the peripheral or central nervous system, rather than stimulation of pain receptors. Diagnosis is suggested by pain out of proportion to tissue injury, dysesthesia and signs of nerve injury detected during neurologic examination. Many patients with neuropathic pain exhibit persistent or paroxysmal pain that is independent of a
stimulus. This stimulus-independent pain can be shooting, lancinating, or burning and may depend on activity in the sympathetic nervous system. Spontaneous activity in nociceptor C fibres is thought to be responsible for persistent burning pain and the sensitization of dorsal horn neurons. Similarly, spontaneous activity in large myelinated A fibres which normally signal innocuous sensations, is related to stimulus-independent paraesthesia and, after central sensitization, to dysesthesia and pain (Woolf 1999). Pain can develop after injury to any level of the nervous system, peripheral or central; the sympathetic nervous system may be involved in causing sympathetically maintained pain. Specific pain conditions in the orofacial region which can mimic a toothache include atypical facial pain, trigeminal neuralgia and atypical odontalgia. Other conditions such as glossopharyngeal neuralgia and atypical trigeminal neuralgia which can mimic dental pain but these conditions are extremely rare (Benoliel 2008).

1.2 **Significance of Orofacial Neuropathic Pain**

Most toothaches have their origin in the pulpal tissues or periodontal structures. Pain of odontogenic origin can be managed well and predictably by dental therapies. Nonodontogenic pain is often difficult to identify and can challenge the diagnostic ability of the clinician. The most important step towards proper management of toothache pain is to be suspicious that the pain may not be of dental origin. Orofacial neuropathic pain can be a debilitating problem which is poorly understood and this condition represents a challenge for clinicians in diagnosis and treatment. Orofacial neuropathic pain refers to many
different disorders such as trigeminal neuralgia, atypical facial pain, glossopharyngeal neuralgia, atypical odontalgia and atypical trigeminal neuralgia. These patients can present to a variety of clinicians including endodontists, orofacial pain dentists, general dentists, specialists in oral medicine, neurologists and otolaryngologists. The complex head and neck anatomy and poorly understood etiologies of these pain conditions make their diagnosis challenging, frequently overlapping with various dental and medical disciplines. There is a significant potential for misdiagnosis and or unnecessary irreversible treatment. Dental and medical practitioners should make referrals to key specialists or to members of an interdisciplinary team at a pain treatment center who have the expertise to appropriately diagnose and manage chronic oral, facial and head pain (Israel 2000).

1.3 **Aim of the Study**

Orofacial neuropathic pain is a well established clinical condition which is managed by both dental and medical clinicians. Patients with pain conditions such as of atypical odontalgia, atypical facial pain and trigeminal neuralgia require treatment which often includes consultation and interdisciplinary treatment by both medical and dental clinicians. Endodontists, orofacial pain dentists, general dentists, specialists in oral medicine, neurologists and otolaryngologists are all likely to deal with the diagnosis and management of such conditions. Patients with orofacial neuropathic pain can present to both dental and medical practitioners (Vickers 2000). One of the challenges faced in
treating patients with these pain conditions is inter-clinician variability at various stages of management, including diagnosis and treatment. The aim of this study is to compare the views of dental and medical clinicians who deal with atypical facial pain, trigeminal neuralgia and atypical odontalgia regarding the proper terminology, diagnostic tools and interdisciplinary treatment approach.

1.4 **Hypothesis**

We hypothesize that there will be greater than 60% agreement in diagnostic terminology among clinicians dealing with atypical facial pain (AFP), trigeminal neuralgia (TN) and atypical odontalgia (AO).
2. REVIEW OF LITERATURE

The most common presenting complaint of dental patients is a “toothache” and such pain is usually odontogenic with its origin in the pulpal tissues or periodontal structures. This odontogenic pain is relatively easy to diagnose, and treatment is predictable. Non-odontogenic toothaches are often difficult to identify and can challenge the diagnostic ability of the clinician. Misdiagnosis can lead to irreversible treatment including endodontic therapy and extractions (Conti 2003). The neuropathologies affecting the teeth include conditions like atypical facial pain, trigeminal neuralgia and atypical odontalgia. These conditions should be considered in cases of dental pain without any obvious pathology, particularly in an endodontic evaluation. To determine the source of the pain, the dentist needs to obtain a detailed medical history with emphasis on the duration, severity, presenting pattern and relieving factors of the condition. Thorough knowledge of non-odontogenic causes of pain can prevent unnecessary irreversible dental treatment. The diagnosis and management of non-odontogenic pain is often best accomplished by working with a multidisciplinary team comprised of a dentist with experience in orofacial pain conditions, neurologist and/or otolaryngologist (Israel 2000).

2.1 Atypical Facial Pain

Atypical facial pain (AFP) is defined as persistent idiopathic facial pain by the International Headache Society (IHS). It is a poorly understood
condition, which still lacks clear diagnostic criteria and proper treatment. The pain is described as “persistent facial pain that does not have the characteristics of cranial neuralgias and is not attributable to another disorder” (Agostoni 2005). A history of multiple ineffective treatments is common. Surgical treatments are often performed, including tooth extractions, endodontic procedures, exploratory surgery, sinus surgery, and temporomandibular joint (TMJ) surgery, that have no effect on the pain and often complicate the problem. The lack of a definite etiology and positive diagnostic criteria has led some authors to recommend against using the term. This is in part a reaction to the historic association between AFP and psychological disorders. Psychological abnormalities are often present in AFP but are likely to be a consequence of chronic pain. Behavioral and psychological abnormalities are part of chronic pain disorders regardless of the original source or site of pain (Marbach 1990). Even though AFP has yet to be explained, clinicians still apply the term to a group of patients who defy other diagnostic criteria and who share some common features.

2.2 Patho-physiology and clinical features of Atypical Facial Pain

Numerous theories have been proposed for the etiology of AFP, but a definite etiology has not emerged. The term was first used to describe patients with chronic facial pain who did not respond to neurosurgical procedures aimed at interrupting pain pathways in the peripheral and central nervous system (McElin 1947). The model of pain as a sensation generated by a peripheral stimulus and relayed to the brain, and the lack of predictable effects of sectioning
nerves suggested that a psychological abnormality was the likely cause. The absence of a local orofacial abnormality or ongoing injury supported this assumption and it has been suggested that more positive behavior management, including treatment of anxiety and depression, might lead to greater patient satisfaction and play a role in reducing the development of chronic pain. (Hamilton 1996).

Psychosocial changes often dominate the clinical picture of AFP, but their role as cause or effect is not clear. Neuropathic pain may result from tissue injury that affects peripheral nerves, resulting in CNS changes, causing persistent pain. Neuralgia inducing cavitational osteonecrosis (NICO) has been proposed as a cause of AFP (Bouquot 1992). Pathologic jaw bone cavities have been proposed as the cause of not only continuous or nearly continuous facial pain but also intermittent paroxysmal pain disorders but the proposed theory of necrotizing intrabony cavitational osteonecrosis is controversial (Sciubba 2009).

AFP is a term used for persistent facial pain with no typical characteristic of cranial neuralgias and not associated to physical evidence or demonstrable organic causes. The term atypical facial pain was first introduced by Frazier and Russell in 1924 (Agostoni 2005). Various terminologies have been used to describe this pain condition including atypical facial pain, facial arthromyalgia, persistent idiopathic facial pain and atypical facial neuralgia.

A targeted history and an accurate examination are crucial to correctly classify this facial pain. The process necessary to establish the diagnosis of AFP is complex and the diagnostic assessment must include investigations required
to detect alternative causes before the diagnosis of AFP is established. Because
there are no definitive criteria for the diagnosis of AFP, the process is directed
toward eliminating other possible causes (Lewis 2007). A comprehensive
assessment to rule out other conditions is critical and a full assessment of the
physical structures of the head and neck and their functional competence should
be performed. Occasionally, atypical presentations of odontogenic pain can
mimic AFP, which necessitates that pulp testing be done on all teeth in the region
that could refer pain to the principle site of pain and on some occasions these
cases are associated with endodontic therapy after completion of treatment
(Campbell 1990). Questionable teeth should be tested with the electric pulp
tester and thermal testing with cold and heat. Periodontal tissues should also be
carefully examined for the presence of neuropathic periodontal triggers (Padilla
2000). These often occur around teeth that have encountered prior traumatic
injury, such as tooth fracture, fractured restorations, and food impaction into the
periodontal structures. Diagnosis of incompletely fractured teeth in patients with
longstanding orofacial pain symptoms can present as a diagnostic problem. With
appropriate endodontic or restorative treatment, symptoms can be relieved in the
majority of cases but if undiagnosed these cases are likely to be misdiagnosed
as a neuropathic pain (Nguyen 2009, Brynjulfsen 2002).

Psychiatric diagnostic issues are important from the perspective of the
treating physician or dentist, with emphasis on practical ways of identifying and
managing patients with psychosocial complications of their presenting
complaints. AFP may cause psychosocial behavioral problems that have to be
treated as part of comprehensive management. These abnormalities may be significant in the continuation of symptoms and may prevent other treatments from being effective. A family history of chronic pain disorders or other psychosocial behavioral problems should be explored (Harness 1989).

Common clinical features of AFP include pain in the face sometimes including jawbone, which is present daily and persists for all or most of the day. Pain is confined at onset to a limited area on one side of the face, deep ache, and poorly localized. In addition, the pain is not associated with numbness or tingling or other physical signs with no abnormalities in laboratory or imaging studies (Woda 2001).

Neurological and physical examination findings, by definition of AFP, are normal. Pain evoked responses after stimulation are less common than with trigeminal neuralgia. Palpation- and manipulation-induced tenderness of the TMJ is associated with TMJ syndrome and less so with other cephalgias or facial pain syndromes.

2.3 **Diagnosis and management of Atypical Facial Pain**

Imaging of the dental, sinus, and osseous structures of the face and jaws is important in patients with suspected AFP. Patients are often are suspicious that organic pathology is responsible for their pain syndrome and often resist a diagnosis of AFP until it is clear that no structural pathology exists. Radiographs of the teeth and alveolar structures are essential as are sinus films to make certain that occult sinus disease is not responsible for the symptoms. MRI of the
brain with and without gadolinium is the imaging modality of choice. CT scanning of the brain with contrast has a lower yield than MRI because of poorer resolution of the posterior fossa and cranial nerves. Without detailed neurophysiologic and quantitative sensory examinations, neuropathic cause of chronic orofacial pain may be overlooked (Agostoni 2005, Forssell 2007).

Anesthetic testing can be a useful part of the workup of patients thought to have AFP. Topical anesthetics can be applied to the region of pain to rule out atypical presentations of neuropathy or neuralgias that present with active superficial nociceptors in the epithelium and skin. Infiltration anesthesia around the teeth and into soft tissue structures can isolate local triggers and define the region of pain. Intraligamentary injection of the teeth can isolate individual teeth and periodontal structures that are triggering symptoms (Clark 2006).

As with most complex physical or neurologic problems, consultation is often advisable during the diagnostic and case planning phase of care. Consultation with dental specialists, such as endodontists, can provide new findings or confirm that no odontogenic pathology is present (Israel 2000). Medical consultations usually include primary care physicians or specialists in internal medicine to rule out metabolic disease and consultations with neurologists, otolaryngologists, and behavioral specialists.

The management of AFP requires a specific knowledge of the diagnostic criteria. This is extremely important in the process of differential diagnosis and in the choice of the most accurate and effective therapeutic treatment strategy. The treatment and management of AFP requires a multidisciplinary approach
including neurologists, otolaryngologists, dentists, endodontists and behavioral specialists (Israel 2000, Conti 2003). Treatment is less effective than in other facial pain syndromes. Medication like amitriptyline and gabapentin is usually the first course of treatment. Anti-convulsants and anti-depressants are the mainstays of medication treatment. Surgical procedures generally are not successful with AFP patients.

2.4 Trigeminal Neuralgia

Trigeminal neuralgia (TN), is a neuropathic disorder of the trigeminal nerve that causes episodes of intense pain in the eyes, lips, nose, scalp, forehead, and jaw. John Fothergill gave the first full and accurate description of trigeminal neuralgia in 1773, but early descriptions of trigeminal neuralgia can be found in descriptions of facial pain by Ibn Sina (980–1073AD) in an Arabic text. An example of early interventional treatment is that by Locke in 1677, who applied sulphuric acid to the face of the Duchess of Northumberland in an attempt to treat her trigeminal neuralgia (Prasad 2009). The International Association for the Study of Pain defines classical idiopathic trigeminal neuralgia as a sudden, usually unilateral, severe, brief, stabbing, recurrent pain in the distribution of one or more branches of the fifth cranial nerve.

2.5 Patho-physiology and clinical features of Trigeminal Neuralgia

Several theories have been proposed explaining the pathophysiology of pain in TN but the precise mechanism of pain production is still unclear. One
theory suggests demyelination as a result of tumor or vascular compression of a nerve root by an overlying blood vessel can lead to abnormal transmission and processing of impulses along the trigeminal nerve. Moreover, demyelination promotes ephaptic neural transmission, specifically development of abnormal contacts between adjacent nerve axons, which results in inappropriate spread of action potentials and activation of one nerve on activity in another (Zakrzewska 1997). Histopathological examination of trigeminal nerve from patients with compression of the nerve root by a blood vessel reveals focal loss of myelin, close apposition of the demyelinated axons and lack of intervening astrocytic processes. Extensive use of magnetic resonance imaging (MRI) to document the presence of benign or malignant lesions, plaques of multiple sclerosis and proximity of vessels to the trigeminal nerve has supported this postulate (Zakrzewska 2002). Similarly, intraoral compression of the mental nerve by an ill-fitting denture can lead to trigeminal neuralgia-like symptoms. One theory suggests chronic irritation or trauma to one of the branches of trigeminal nerve can cause ectopic action potentials and failure of segmental inhibition, leading to symptoms of trigeminal neuralgia.

Different terminologies have been used in the description of this pain condition which includes trigeminal neuralgia, tic douloureux, prosopalgia, the Suicide Disease and Fothergill's disease. The term trigeminal neuralgia best describes this condition and is largely accepted in the medical and dental field.

TN is a pain syndrome typified by the patient's history and due to the nature of its initial presentation; it is wrongly associated with dental pathology.
The pain follows V1, V2 or the V3 branches of the fifth cranial, trigeminal nerve. It can last from a few seconds to a few minutes. The intervals between attacks are pain free. With time the severity and frequency of pain episodes increases. Trigeminal neuralgia is characterized by spontaneous remissions that may last months or even years. The paroxysms of pain may occur in rapid succession while the patient is awake, but they rarely occur during sleep. Epidemiologic information indicates that TN affects 4-5 people per 100,000 population and has a predilection for women over 40 years of age. TN attacks can be attributed to the stimulation of trigger areas which are around the nose and mouth ipsilateral to the pain. These trigger areas are a characteristic feature of trigeminal neuralgia. It adversely affects patient’s lifestyle, as attacks can be provoked by innocuous stimuli like talking, chewing, or light touch. In severe cases wind breeze, cold, warm or wintry weather change can trigger an attack. The pain of trigeminal neuralgia in its initial presentation is often falsely attributed to pathology of dental origin (Nurmikko 2001, Love 2001). Commonly it is the failure of dental treatment to provide long-term pain relief that raises a suspicion of trigeminal neuralgia. Because of the difficulty in its early diagnosis, many patients may go untreated for long durations and often the patients have seen multiple healthcare providers due to frequent misdiagnosis before a definitive diagnosis of TN is reached.
2.6 **Diagnosis and Management of Trigeminal Neuralgia**

No single test can diagnose trigeminal neuralgia and hence the diagnosis is confirmed by ruling out other conditions. Although the diagnosis remains based exclusively on history and symptomatology, modern diagnostic techniques, particularly high-resolution MRI, provides valuable new insight into the pathophysiology of these cases with additional implications for therapeutic strategies (Meaney 1995). Response to anticonvulsant medication such as carbamazepine, gabapentin has been used as a diagnostic tool for trigeminal neuralgia. MRI of the brain and repeated neurological evaluations should be implemented in all patients with TN to rule out the presence of underlying disease (Sato 2004). The differential diagnosis is important and should be considered before making the diagnosis of TN as the condition may be secondary to other pathology. These include cysts and tumors of the head and neck region, dental pain of pulpal origin, cluster headache, chronic inflammatory demyelinating polyneuropathy and multiple sclerosis (Elias 2002).

Treatment of trigeminal neuralgia uses a multidisciplinary approach that brings together neurologist, neurosurgeons, specialists in pain management, otolaryngologists, psychologists, dentists, and pharmacologists to devise a customized approach to treating trigeminal neuralgia. Each of these specialists collaborates closely to provide the most appropriate care.

The first choice of treatment is drug therapy. Various antiepileptic drugs are used, including carbamazepine, oxcarbazepine, lamotrigine, phenytoin and gabapentin. Carbamazepine is most often the drug of choice but common
adverse effects include sedation, fatigue, dizziness, blurred vision, nausea, vomiting and allergic skin reactions. Additionally, routine monitoring of hematologic and hepatic profiles is required during treatment. Oxcarbazepine is a safer alternative to carbamazepine as it does not require complete blood cell count and liver function monitoring tests. Other effective medications include baclofen, a γ-aminobutyric acid receptor agonist, and tizanidine, an α2-adrenergic agonist. For patients with TN who become refractory to pharmacological treatment or cannot tolerate its adverse effects, surgical intervention is recommended which includes peripheral surgery, percutaneous ablative procedures, stereotactic radiosurgery and microvascular decompression (Zakrzewska 2002).

2.7 **Atypical Odontalgia**

Atypical odontalgia (AO) is one of the most frustrating conditions that challenge dental clinicians. John Hunter, an English surgeon had described this condition more than 200 years ago. McElin and Horton first reported this condition in 1947. Although this is an accepted clinical condition, cases of AO are often overlooked in the differential diagnosis and seldom reported. The International Association for the Study of Pain (IASP) has created nomenclature titled Taxonomy of Chronic Pain which includes this condition. Researchers and investigators have described AO by using different terminology, which includes the following terms: neurovascular odontalgia, oral neuropathic pain, atypical facial pain, and facial arthromyalgia and idiopathic odontalgia.
2.8 **Patho-physiology and clinical features of Atypical Odontalgia**

The pathophysiology of AO been proposed to be psychogenic, vascular, neuropathic or idiopathic but the exact mechanism still remains ambiguous. Different neuropathic mechanisms may be at work: nociceptor sensitization, phenotypic changes and ectopic activity from the nociceptors. Central sensitization possibly maintained by ongoing activity from initially damaged peripheral tissues, sympathetic abnormal activity, alteration of segmental inhibitory control, and hyper- or hypoactivity of descending controls can contribute to the pathophysiology of AO. Nociceptors are sensory neurons that are found in any area of the body that can sense pain either externally or internally (Marbach 1996). Nociceptor sensitization has been used to explain the pathophysiology of AO along with other theories like central sensitization and sympathetic abnormal activity. The exact mechanism is still unclear and researchers have proposed different explanatory theories. Woda and Pionchon hypothesized a unified concept, that the idiopathic pain entities depend on one or several neuropathic mechanisms, the development of which is triggered or favored by one or several events or risk factors (Woda 2000). These risk factors include local inflammatory, infectious, or mechanical irritation as well as minor nerve trauma. They proposed that these different mechanisms may be at work possibly at the same time. Marbach noted the similar etiology between pain from atypical odontalgia and phantom limb pain (Marbach 1996).

The classical manifestation of AO includes throbbing, persistent pain in teeth or alveolar process for a prolonged period of time without any pathological,
clinical, or radiological findings. AO often follows dental or surgical procedures such as pulp extirpation, apicoectomy, tooth extractions, or exenteration of the contents of the maxillary antrum. It can sometimes be idiopathic which can make diagnosis a challenge. Although the pain is chronic in nature, the patient’s sleep is undisturbed, and there may be a brief symptom-free period on waking. AO has a higher rate of incidence in the maxillary molar and premolars and can affect all ages, except children, with preponderance among women in mid forties. Patients rarely find relief from analgesics, including narcotics. Results from a diagnostic local anesthetic infiltration and block are mostly inconclusive (Pertes 1995).

Two conditions that have been linked to this pathology are osteoporosis that appears during menopause and neuralgia-inducing cavitational osteonecrosis (Bouquot 1992, Agostoni 2005). These theories are controversial and the clinical significance of neuralgia inducing cavational osteonecrosis or cavational osteopathosis, has been called into question. Patient’s psychological status has been reported as an underlying cause of atypical odontalgia but there is a lack of scientific evidence to support this claim.

2.9 **Diagnosis and management of Atypical Odontalgia**

The diagnosis of AO is made by exclusion. AO is a chronic form of dental pain without signs of pathology which can affect apparently normal teeth. The diagnostic criteria proposed by Graff-Radford and Solberg for AO (Graff-Radford 1992) includes
1. Pain in a tooth or a tooth site
2. Continuous or almost continuous pain
3. Pain persisting for more than four months
4. No sign of local or referred pain
5. An equivocal somatic nerve block.

Pertes et al revised the above criteria in 1995 to include pain’s lack of response to treatment (Pertes 1995)

Management of the patient is better achieved through a multidisciplinary approach intended to improve patient’s quality of life as well as relieving the pain. This involves reducing the disability caused by the pain often with an increase in mood, activity and social contact. A thorough dental examination including radiographs and Cone-beam computed tomography scan is recommended. Cone-beam computed tomography improves identification of patients without periapical bone destruction, which may facilitate differentiation between AO and symptomatic apical periodontitis (Pigg 2011). Treatment for atypical odontalgia is similar to treatment for other neuropathic conditions. The treatment of choice is a tricyclic antidepressant such as amitriptyline, alone or in combination with a phenothiazine. The outcome is usually fair, with many patients obtaining complete relief from pain. Although other tricyclics such as imipramine, nortriptyline, and dothiepen have been suggested, low dose of amitriptyline is used more frequently. Some results have been reported with other medications such as gabapentin, clonazepam, baclofen, doxepin, α- and β-blockers and MAO inhibitors especially in cases where tricyclic antidepressants were not tolerated.
Topical capsaicin has been used successfully to control neuropathic pain and it is simple yet effective treatment for patients with atypical odontalgia. It is important to defer any invasive procedures until a definitive diagnosis of AO has been reached (Melis 2003).
3. MATERIALS AND METHODS

3.1 **Web-based Survey Research**

The past decade has seen a tremendous increase in internet use and web-based communication. The technology for online survey research is young and evolving. Until recently, creating and conducting an online survey was a time-consuming task requiring familiarity with web authoring programs, HTML code, and scripting programs. Today, survey authoring software packages and online survey services make online survey research much easier and faster. Yet many researchers in different disciplines including dentistry have not used this tool to its maximum potential.

Major advantages of web-based surveys include easy access, instant distribution, and reduced costs. In addition, this tool allows questionnaires and surveys to reach a wide population with minimum cost and time.

Very few web-based surveys have been conducted in dentistry and to the knowledge of the author this is the first web-based survey on orofacial pain conditions, comparing inter-clinician variability among medical and dental practitioners.

3.2 **Survey Methodology**

An email invitation to participate in the online survey was sent to 100 US endodontists, 100 general dentists, 100 specialists in oral medicine, 100 neurologists and 100 otolaryngologists. The e-mail addresses were collected
from the information available in the public domain of clinicians in university settings. The survey included three hypothetical case scenarios. The e-mail addresses were collected from doctor’s contact information available in the public domain over the internet. A subscription service of Qualtrics was used for the electronic survey and the data collected was analyzed using statistical software SPSS 19. The personal identifiers of respondents were removed from the collected data. The clinicians were presented with hypothetical cases of atypical odontalgia (AO), atypical facial pain (AFP), and trigeminal neuralgia (TN). These cases of neuropathic pain were constructed using a review of the literature and consultation with a facial pain expert. The case construction process used information like age and sex prediction for each condition, most common area affected, and a common clinical presentation with a history suggestive of the condition. The survey respondents were presented with a questionnaire with a choice of different terminology, diagnostic tests and referral options. The survey request was distributed by sending a link to the hypothetical cases and questionnaires by blast email to the randomly selected dental and medical practitioners. As a way of thanking respondents for their time and participation, the Department of Endodontics at the University of Illinois at Chicago promised to donate $2 to the American Red Cross for each completed survey. Those who clicked on the survey link indicated their consent to participate. One week after the initial survey request, a reminder email was sent to the respondents and the survey was closed after 6 weeks. The completed survey was used to investigate
terminology, diagnostic tests and referral options of the contacted medical and dental clinicians.

3.3 **Case 1- Hypothetical scenario and survey questions**

Mrs. Jones is 42 years old and presents with a three year history of pain in one side of the face mostly in the cheeks and jaws. The pain began gradually a few years prior and she has had periods of weeks when the pain disappeared. In the past few months, it has been continuous with few, if any, periods of remission. When she has pain, it fluctuates in severity from 2–8 on a visual analogue scale (VAS) of 1–10, with in average score of 5. She describes the pain as facial pain which is burning, aching or cramping, sometimes extending into the upper neck or back of the scalp. The pain is not associated with sensory loss or other physical signs. Pain is confined at onset to a limited area on one side of the face, deep ache, and poorly localized.

She has a medical history of mild depression and anxiety. She was recently divorced and is now bringing up a 16 year old girl on her own. She works in a financial advisory office and mentioned that there is increased stress at work.

Possible working diagnosis terminology

1. Atypical Facial pain
2. Facial arthromyalgia
3. Persistent idiopathic facial pain
4. I don’t know

Investigations

1. Conventional Radiography
2. Advanced imaging including neuroimaging and MRI
3. Blood tests including complete blood count (CBC), blood chemistry tests and blood enzyme tests
4. All the above
5. No investigations

Possible referral of patient to
1. Orofacial pain and oral medicine dentist
2. Neurologist
3. ENT doctor
4. Tertiary care center with a multidisciplinary team consisting of neurologist, psychiatrist, ENT doctor, dentists and clinical psychologist.

3.4  **Case 2- Hypothetical scenario and survey questions**

Mr Paines is a 60 year old healthy Caucasian patient and presented with a chief complaint of a sharp, shooting pain on the left side of his face. The pain began about three months ago but he mentions he had a similar episode one year ago when it lasted for one month and disappeared completely without any treatment. Each episode of pain lasts for a few seconds but sometime it last several minutes. In between episodes of pain he is completely pain free. The pain begins in the left upper front teeth and then spreads across the whole cheek up to the ear. On a VAS of 1-10, he grades an average 7.

He describes the pain as sharp, shooting, stabbing, stinging, tender, exhausting, terrifying and unbearable. It is made worse when eating, shaving, brushing and
talking. He has mild anxiety, depression, and hypertension well managed by medications. Mr Paines is a manager in a restaurant but has taken medical leave due to this pain. He is a widower and his only son rarely talks to him. The pain is not associated with sensory loss or other physical abnormalities.

Possible working diagnosis terminology

1. Trigeminal neuralgia
2. Tic douloureux
3. prosopalgia
4. Fothergill's disease
5. I don't know

Investigations

1. Conventional Radiography
2. Advanced imaging including CT scan, neuroimaging and MRI
3. Blood tests including complete blood count (CBC), blood chemistry tests and blood enzyme tests
4. All the above
5. No investigations

Possible referral of patient to

1. Orofacial pain and oral medicine dentist
2. Neurologist
3. ENT doctor
4. Tertiary care center with a multidisciplinary team consisting of neurologist, psychiatrist, ENT doctor, dentists and clinical psychologist.
3.5 **Case 3- Hypothetical scenario and survey questions**

Ms Connors is 35 years old and has had orofacial pain for 5 years. The pain began in her upper left bicuspid tooth after a crown prep and she had root canal therapy at an endodontist's office. She returned back to the endodontist with a chief complaint of persistent pain after treatment. She visited multiple dentists for treatment but was very frustrated and had the tooth extracted, but has had limited pain relief. In the edentulous site she complains of continuous pain. The pain scores on VAS range (1-10) averages of 4. She has no pain during sleep but it fluctuates in intensity during the day and it is worse in the evenings. She describes the pain as boring, aching, tender, tiring, miserable and nagging. The pain is now located both intraorally and extraorally on the left dentoalveolar region. Analgesics do not provide any relief.

Mrs. Connors has a history of severe anxiety and headaches. She has been married twice and never had children. She was a foster child with a very difficult childhood. Her work in a grocery store as a cashier is stressful and she has considered leaving it. The lack of diagnosis and inability of 4 dentists and 2 physicians has led to immense frustration. Examination reveals no physical abnormalities and diagnostic tests show no abnormality on radiographs and no obvious cause of tooth pain can be found.

**Possible working diagnosis terminology**

1. Atypical odontalgia
2. Neurovascular odontalgia
3. Atypical facial pain
4. Idiopathic odontalgia
5. Phantom tooth pain
6. I don’t know

Investigations
1. Conventional Radiography
2. Advanced imaging including CT scan, neuroimaging and MRI
3. Blood tests including complete blood count (CBC), blood chemistry tests and blood enzyme tests
4. All the above
5. No investigations

3.6 **Statistical Analysis**

Of the 500 dental and medical practitioners who were contacted, 126 responded to the survey requested. The response rate was 25.2% (oral medicine =21%, general dentist= 28%, endodontist=31% ,ENT=22%,neurologist=24%). Of the 25.2% practitioners who responded to the e-mail request, 93 % completed the entire survey. All participant data were de-identified.
TABLE 1:
RESPONSE RATE

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
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<td>28</td>
<td>22.2</td>
<td>22.2</td>
<td>22.2</td>
</tr>
<tr>
<td>Endodontist</td>
<td>31</td>
<td>24.6</td>
<td>24.6</td>
<td>46.8</td>
</tr>
<tr>
<td>Oral Medicine Specialist</td>
<td>21</td>
<td>16.7</td>
<td>16.7</td>
<td>63.5</td>
</tr>
<tr>
<td>Neurologist</td>
<td>24</td>
<td>19.0</td>
<td>19.0</td>
<td>82.5</td>
</tr>
<tr>
<td>Otolaryngologist</td>
<td>22</td>
<td>17.5</td>
<td>17.5</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>126</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1: Response Rate

Responses to the multiple-choices of the 9 questions were analyzed with statistical software (SPSS version 19; SPSS Inc, Chicago, USA), using
descriptive statistics and chi square tests of significance (P<0.05) to compare differences in the responses of the dental and medical practitioners. Frequency distributions were used to describe the responses to each question.

In the hypothetical case of atypical facial pain (case 1), 42.1% of respondents chose the diagnostic terminology of atypical facial pain and 23.8% chose persistent idiopathic facial pain. 38.9% of respondents chose investigation of advanced imaging including neuroimaging and MRI; 21.4% of the respondents chose a wide range of investigation including conventional radiography, advanced imaging including neuroimaging and MRI, blood tests including complete blood count (CBC), blood chemistry tests and blood enzyme tests. The majority of respondents 61.1% chose to refer the AFP scenario to a orofacial pain and oral medicine dentist.
Figure 2: Case 1 Distribution of Terminology
Figure 3: Case 1 Distribution of Investigations
Figure 4: Case 1 Distribution of Referral Pattern

In the hypothetical case of trigeminal neuralgia (case 2), a majority 73.8% of respondents chose the diagnostic terminology of TN. 48.4% of respondents chose investigation of advanced imaging including neuroimaging and MRI; 17.5% of the respondents chose wide range of investigation including conventional radiography, advanced imaging including neuroimaging and MRI, blood tests including complete blood count (CBC), blood chemistry tests and blood enzyme tests. The majority of respondents 46.8% chose to refer the TN scenario to a neurologist and 20.6% chose a tertiary care center with a multidisciplinary team consisting of neurologist, psychiatrist, ENT doctor, dentists and clinical psychologist.
Figure 5: Case 2 Distribution of Terminology
Figure 6: Case 2 Distribution of Investigations
Diagnostic terminology: In the hypothetical case of atypical odontalgia (case 3), a majority 42.9% of respondents chose the diagnostic terminology of atypical facial pain and only 11.3% chose the terminology AO. 27.8% of respondents chose investigation of conventional radiography and 26.2% chose advanced imaging including neuroimaging and MRI. The majority of respondents 59.5% chose to refer the AO scenario to a orofacial pain and oral medicine dentist.
Figure 8: Case 3 Distribution of Terminology
Figure 9: Case 3 Distribution of Investigations
Investigation and the pattern of referral choices are on most occasions dictated by the skills and experience of the practitioner and hence frequency distributions were used to describe the responses to such questions. Consistency in diagnostic terminology facilitates discussion among clinicians, researchers, and patients and in this study the diagnostic terminology of atypical

![Figure 10: Case 3 Distribution of Referral Pattern](image)

**TABLE 2:**

<table>
<thead>
<tr>
<th></th>
<th>Diagnosed $\text{AFP}$</th>
<th>Diagnosed $\text{TN}$</th>
<th>Diagnosed $\text{AO}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-Square</td>
<td>$2.093^a$</td>
<td>$34.917^b$</td>
<td>$71.479^b$</td>
</tr>
<tr>
<td>df</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Asymp. Sig</td>
<td>$.147$</td>
<td>$.000$</td>
<td>$.000$</td>
</tr>
</tbody>
</table>
facial pain (AFP), trigeminal neuralgia (TN) and atypical odontalgia (AO) was considered to be the most appropriate for case scenario 1, 2 and 3 respectively. A chi-square test for diagnostic terminology showed that of the responses for AFP was not significant (p>.05) and this was primarily due to respondents choosing between AFP and persistent idiopathic facial pain. In the case scenario 2, the responses for TN was significant (p<.05) and this was due to most respondents choosing TN as an appropriate diagnostic terminology. In case scenario 3, the responses for the diagnostic terminology AO was significant (P<.05) and was primarily due to the fact that most respondents chose the diagnosis as atypical facial pain (AFP) for this condition.
3.7 **IRB/ACC Approval**

**UNIVERSITY OF ILLINOIS AT CHICAGO**

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Folk Street
Chicago, Illinois 60612-7227

**Exemption Granted**

August 25, 2011

Harish Koratkar, BDS
Endodontics
801 South Paulina Street, Room #304D
MC 542
Chicago, IL 60612
Phone: (651) 260-4497 / Fax: (312) 996-3375

**RE: Research Protocol # 2011-0409**

“Web-based Survey of Different Dental and Medical Practitioners on Oro-facial Pain Conditions”

Dear Dr. Koratkar:

Your Claim of Exemption was reviewed on August 25, 2011 and it was determined that you research meets the criteria for exemption. You may now begin your research.

**The specific exemption category under 45 CFR 46.101(b) is:**
(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless:
(i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

You may now implement the amendment in your research. Please note the following information about your approved amendment:

**Exemption Period:** August 23, 2011 – August 24, 2014  
**Amendment Approval Date:** August 25, 2011

UIC Amendment #1, dated July 23, 2011 (received August 8, 2011), involves a change in the email request to participants. The change includes the following additional text, "As a way of thanking you for your time and participation, the Department of Endodontics at the University of Illinois at Chicago will donate $2 to the American Red Cross for each completed survey."

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**Please note the Review History of this submission:**

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<th>Receipt Date</th>
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<th>Review Process</th>
<th>Review Date</th>
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<td>08/23/2011</td>
<td>Response To Modifications</td>
<td>Exempt</td>
<td>08/25/2011</td>
<td>Approved</td>
</tr>
</tbody>
</table>
You are reminded that investigators whose research involving human subjects is determined to be exempt from the federal regulations for the protection of human subjects still have responsibilities for the ethical conduct of the research under state law and UIC policy. Please be aware of the following UIC policies and responsibilities for investigators:

1. **Amendments** You are responsible for reporting any amendments to your research protocol that may affect the determination of the exemption and may result in your research no longer being eligible for the exemption that has been granted.

2. **Record Keeping** You are responsible for maintaining a copy all research related records in a secure location in the event future verification is necessary, at a minimum these documents include: the research protocol, the claim of exemption application, all questionnaires, survey instruments, interview questions and/or data collection instruments associated with this research protocol, recruiting or advertising materials, any consent forms or information sheets given to subjects, or any other pertinent documents.

3. **Final Report** When you have completed work on your research protocol, you should submit a final report to the Office for Protection of Research Subjects (OPRS).

4. **Information for Human Subjects** UIC Policy requires investigators to provide information about the research protocol to subjects and to obtain their permission prior to their participating in the research. The information about the research protocol should be presented to subjects in writing or orally from a written script. When appropriate, the following information must be provided to all research subjects participating in exempt studies:
a. The researchers affiliation; UIC, JBVMAC or other institutions,
b. The purpose of the research,
c. The extent of the subject’s involvement and an explanation of the
   procedures to be followed,
d. Whether the information being collected will be used for any purposes
   other than the proposed research,
e. A description of the procedures to protect the privacy of subjects and the
   confidentiality of the research information and data,
f. Description of any reasonable foreseeable risks,
g. Description of anticipated benefit,
h. A statement that participation is voluntary and subjects can refuse to
   participate or can stop at any time,
i. A statement that the researcher is available to answer any questions that
   the subject may have and which includes the name and phone number of
   the investigator(s).
j. A statement that the UIC IRB/OPRS or JBVMAC Patient Advocate
   Office is available if there are questions about subject’s rights, which
   includes the appropriate phone numbers.

Please be sure to:

➔ Use your research protocol number (2011-0409) on any documents or
  correspondence with the IRB concerning your research protocol.

We wish you the best as you conduct your research. If you have any questions or
need further help, please contact the OPRS office at (312) 996-1711 or me at (312)
355-1404. Please send any correspondence about this protocol to OPRS at 203
AOB, M/C 672.

Sincerely,
Sheilah R. Graham, BS
IRB Coordinator, IRB #2
Office for the Protection of Research Subjects

cc: Christopher Wenckus, Endodontics, M/C 642
    Bradford R. Johnson, Endodontics, M/C 642
4. DISCUSSION

4.1 Findings of this Study

For at least the last decade, standardizing terminology has been of major importance in healthcare and this is important to facilitate a productive dialogue among clinicians, researchers, and patients. Variations in diagnostic terminology and management of illness can lead to failure of early diagnosis, misdiagnosis and chronification of certain illnesses. Certain important findings of the study were the consistent use of the diagnostic terminology for TN. This highlights that there is widespread agreement regarding the International Association for the Study of Pain definition of trigeminal neuralgia as a sudden, usually unilateral, severe, brief, stabbing, recurrent pain in the distribution of one or more branches of the fifth cranial nerve. However, in case scenario 3, it was interesting to find that the majority of respondents chose the diagnostic terminology of atypical facial pain for atypical odontalgia. Atypical odontalgia was considered a focalized form of atypical facial pain but International Association for the Study of Pain has classified it as a separate entity. Consensus for the diagnostic criteria among pain researchers using ontological principles have improved related taxonomy of AO and have proposed the use of persistent dentoalveolar pain (PDAP). This consensus was published after this research was already in progress and hence PDAP was not in the choices for terminology (Nixdorf 2011).

Chronic orofacial pain studied in this research represents a diagnostic and treatment challenge for the clinician. Some conditions, such as atypical facial pain...
pain and atypical odontalgia still lack proper diagnostic criteria, and their etiology is not known. The recent development of imaging methods for the examination of the trigeminal somatosensory system offers several tools for diagnostic and etiological investigation of orofacial pain. Advanced imaging investigations have greater diagnostic accuracy and sensitivity than clinical examination in the detection of the neurogenic and neuropathic abnormalities of either peripheral or central origin that may underlie symptoms of orofacial pain (Shintaku 2006). Most respondents in this study chose advanced imaging as a diagnostic tool and this is consistent with the improvement in technology and its awareness among practitioners.

The majority of respondents chose to refer patients to a neurologist, or orofacial pain / oral medicine dentist. There appears to be a need to increase awareness among medical and dental practitioners about the occurrence of chronic orofacial pain and it is now well recognized that patients with orofacial pain often have confounding co-morbidity of chronic pain elsewhere, and these patients may therefore need a multidisciplinary team to help them to manage their pain (Elrasheed 2004). The multiple referral and investigations associated with this condition increase the frustration of the patient in failure to seek treatment and also increases the burden on the healthcare cost.

This study highlights inter-clinician variability in diagnosis and treatment among clinicians dealing with atypical odontalgia(AO), atypical facial pain(AFP) and trigeminal neuralgia(TN) . An interesting observation in the case scenario of AO (case 3) was the majority of respondents chose the diagnostic terminology of
AFP, although AO is an established independent clinical entity. Although, the differences in diagnostic terminology have limited influence on actual treatment rendered, the importance of correct terminology cannot be understated. Overall, the study also draws attention to the need for education of orofacial pain conditions both at undergraduate and postgraduate level of medical and dental education. Patients with such neuropathic pain conditions require treatment which includes consultation and an interdisciplinary treatment approach of both medical and dental clinicians. Endodontists, orofacial pain dentists, general dentists, specialists in oral medicine, neurologists and otolaryngologists are all likely to deal with the diagnosis and management of such conditions and a consensus in diagnostic terminology and uniformity in management is recommended.

4.2 Limitations of this Study

Researchers have long recognized that every method of scientific inquiry is subject to limitations and that choosing among research methods inherently involves trade-offs. Web-based surveys offer many advantages over traditional surveys. However, there are also disadvantages that should be considered by researchers contemplating using online survey methodology. Although the study is the first of its kind to report a web-based survey of medical and dental practitioner on orofacial pain, the findings need to be interpreted with caution due to methodological shortcomings. This survey is only a snapshot and the situation
may provide differing results if another time-frame had been chosen. This is an inherent limitation to most survey research. Additionally, it is difficult to make causal inference from this survey and since causal inference is a judgmental process, the results of this study have to be interpreted with the knowledge of such limitations.

Although some studies of web-based survey methods have found that response rates in email surveys are equal to or better than those for traditional mailed surveys (Stanton, 1998; Thompson 2003), these conclusions may be debatable because non-response rate tracking is difficult to ascertain in cases of busy professional (Andrews 2003). The participants of this survey were healthcare professionals and non-response was a concern. Although a response rate of between 20-30% is not unusual in online surveys among professionals, it would have been desirable to have a higher response rate. The non-response error and non-response bias are reasons for concern in the interpretation of the data. The limitations of access to internet, spam filters, firewall issues and software compatibility issues are inherent to online survey.

This study was limited to general dentist, endodontists, oral medicine specialists, neurologists and otolaryngologists. The primary care physicians, oral surgeons, neurosurgeons, psychiatrists and headache specialists are also likely to encounter such clinical situation and could have been included in this study.
4.3 **Future Research**

Future research can be undertaken to compare the views about orofacial neuropathic pain among physicians and dentist. In the past few years collaboration using online environments has become an important research tool because of the interconnectivity enabled by the Internet. Effective and secured survey instruments can be constructed using the subscription services of various companies and this has improved with the advent of surveys being made compatible on the browsers of mobile phones. The social network sites like Facebook and Google + are increasingly attracting the attention of academic researchers intrigued by their affordability and reach. It can be expected that research on clinically relevant topics will be launched on the web pages of such sites attracting a specific target audience.
5. CONCLUSIONS

The result of this study highlights inter-clinician variability in diagnosis and treatment among clinicians dealing with AFP, TN and AO. An interesting observation in the case scenario of AO was the majority of respondents chose the diagnostic terminology of AFP, although AO is an established independent clinical entity. Overall, the study also draws attention to the need for education of orofacial pain conditions both at undergraduate and postgraduate level of medical and dental education.

Patients with neuropathic pain conditions often benefit from treatment which includes both medical and dental clinicians and an interdisciplinary approach. Endodontists, orofacial pain dentists, general dentists, specialists in oral medicine, neurologists and otolaryngologists are all likely to deal with the diagnosis and management of orofacial pain conditions and a consensus in diagnostic terminology and uniformity in management is recommended.
Cited Literature


VITA

Dr. Harish Koratkar

Education:

- Graduated with the dental degree of Bachelor of Dental Surgery (BDS), Nagpur University, India in 1998
- Fellow of Academy of General Dentistry (FAGD) 2010
- Resident in Endodontics, University of Illinois at Chicago 2010-2012
- Concurrently pursuing Master of Science in Oral Sciences, University of Illinois at Chicago 2010-2012

License:

- Licensed to practice dentistry in the State of Minnesota in 2003
- Licensed to practice dentistry in the State of California in 2011
- Licensed to practice dentistry in the State of Delhi, India in 1998

Professional Membership:

- American Association of Endodontists
- American Dental Association
- Coolidge Club
**Publication:**


3. **Koratkar H**. Prescription writing revisited - in press at New York State Dental Journal


**Presentation:**

1. Presented at Nagpur Dental Study Club, Nagpur India in 2009 on “Consideration of neuropathic pain conditions in endodontics”
3. Presented at Rotary Club International India on “Dentistry in United States” in 2004
4. Poster presentation at National Science Convention of India in 2001, New Delhi on “Adult stem cells and Neoorganogenesis”

**Complementary professional activities:**

- *Manuscript reviewer* for the AGD journal “General Dentistry” 2007 to present
- *Executive committee member* of Hibbing Community College-Dental Assisting program 2004-2007
- *Research assistant* on “Adult stem cell and organ regeneration” project of the Indian Council of Medical Research 1999-2001
- Assisted Principal Investigator Dr.BG Matapurkar to obtain two US patents on Neoorganogenesis and neohistogenesis by desired metaplasia of autogenous mesodermal and endodermal stem cells in vivo.
- Dental student representative for the year 1995-96.

**Work history:**

- May 2008 to present in private practice as general dentist in a group practice in Twin Cities of Minnesota
• From Oct 2003 to April 2008 in private practice as general dentist in Hibbing Minnesota. The practice was a busy group practice in rural northern Minnesota.

Work experience in India

From August 2000 to November 2001

• Faculty member in the Center for Dental Studies and Research, India

From Oct-98 to Oct-1999

• Junior Resident, Department of Maxillo-facial Surgery of Safdarjung Hospital, Delhi University.

From July 1997 to June 1998

Completed one year rotational internship from Nagpur University, India