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Evaluation of routine magnetic resonance imaging of patients with chronic orofacial pain

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Abstract. The aim of this study was to evaluate the reported presence of magnetic resonance imaging (MRI) pathologies (demyelination, space-occupying lesions, or trigeminal neurovascular contact within the transition zone) in patients with orofacial pain. Patient histories, demographic characteristics, and clinical features were compared between those with and without a reported MRI pathology. A retrospective service evaluation of all patients who had undergone MRI scanning to aid the diagnosis of orofacial pain conditions between 2012 and 2016 was conducted. Data were collected and statistical analyses (frequency and descriptive) performed. One hundred and twenty-five patients (34 male and 91 female) with a mean age of 50 years were included. MRI pathologies included space-occupying lesions (2.4%), trigeminal neurovascular contact (22.4%), other pathology including small vessel cerebrovascular disease (20%), pineal cyst (1.6%), sinus pathologies (1.6%), and degenerative changes to the cervical spine (0.8%). This study found that patients with a provisional diagnosis of trigeminal neuralgia or trigeminal autonomic cephalalgia, as well as patients with elicited pain, were more likely to have abnormal findings on MRI scanning.

Key words: facial pain; trigeminal neuralgia; magnetic resonance imaging; headache.

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Orofacial pain represents a diagnostic challenge for clinicians and poses a problem for patients as they are often misdiagnosed. Chronic orofacial pain was estimated to affect between five and seven million Americans in 1980[1], and 25–45% of Americans were reported to be affected at some point in their life. Other studies have shown that chronic orofacial pain accounts for 20–25% of all chronic pain conditions[2], and facial pain lasting more than 6 months has been reported in between 1% and 3% of the population[3]. An epidemiological study of seven dental specialties conducted in 2000 revealed that 37% of new patients in dental outpatient clinics had chronic or unexplained facial pain[4]. In clinical populations, women have been found to report facial pain more frequently than men[5].

Clinical examination and laboratory investigations alone are not always sufficient to diagnose a trigeminal nerve pathology because of the complex branching, anastomotic pattern, and variable pathology[6–8]. Neuroradiology specialists have suggested that MRI is, on many occasions, the only imaging modality capable of aiding the diagnosis of trigeminal nerve pathologies such as trigeminal neurovascular contact within the transition zone, together with secondary features such as neural distortion and atrophy[9]. Routine requesting of MRI scanning as a screening tool in patients with chronic orofacial pain is common; however there is currently no evidence base for this.

With appropriate tailoring, MRI scanning can image the entire course of the trigeminal nerve from the brainstem nuclei to the suprahyoid neck, which is of particular importance in identifying patients who could benefit from a surgical intervention[7,8].

Currently there are no set standards for selecting MRI for patients with orofacial pain. Patients are screened with an exploratory purpose, to rule out a pathology. A brief review of the literature did not reveal any studies comparing MRI pathologies to clinical symptoms in patients with chronic orofacial pain. Therefore, the results from the present study could add new fields of interest to the current literature and act as a starting point for the development of MRI guidelines for orofacial pain.

The aim of this study was to evaluate the reported presence of pathologies based on MRI scans (demyelination, space-occupying lesions, or trigeminal neurovascular contact within the transition zone) in a sample of patients with orofacial pain seen at the King's College Hospital orofacial pain service. Patient histories, demographic characteristics, and clinical features were compared between those with and without a reported MRI pathology. It was considered that if the patient group with a reported pathology presented a specific clinical history or features that correlated with positive MRI findings, these could be used to develop criteria for the clinical selection of high-risk patients for MRI investigation.

Materials and methods

The project retrospectively analysed all patients who had undergone an MRI scan to aid the diagnosis of an orofacial pain condition between 2012 and 2016. The patients had been referred by general dental practitioners, general medical practitioners, or hospital-based doctors or dentists to a tertiary referral centre for orofacial pain. All patients were assessed in the clinic by an oral surgeon specializing in the management of chronic orofacial pain and were also seen by a neurologist, neurosurgeon, psychologist, or psychiatrist associated with the clinic if clinically indicated.

The MRI scans of the patients included in the study were evaluated by consultant neuroradiologists. Focused imaging for trigeminal pain syndromes comprised heavily T2-weighted isotropic sequences (e.g., C-FIESTA; Fast Imaging Employing Steady-state Acquisition) to cover the trigeminal nerves within their cisternal portions, together with T2-weighted imaging to encompass the brain and skull base. MRI was performed on a 1.5 Tesla GE Signa system (GE Healthcare, Chicago, IL, USA).

The following MRI outcomes were investigated: normal structure; space-occupying lesion; demyelination; trigeminal neurovascular contact within the transition zone, together with secondary features such as neural distortion and atrophy; other pathology.

Patient demographic and clinical history data were collected and included age and sex, the affected branch of the trigeminal nerve, and the location, frequency, duration, character, and exacerbation of the pain. Data on the outcomes of patients following MRI scanning were also recorded.

IBM SPSS Statistics version 22.0 (IBM Corp., Armonk, NY, USA) was used for the statistical analysis (frequency and descriptive). Differences between groups with and without a reported MRI pathology were analysed using the Student *t*-test and χ^2 test. The data collected and analysed will be used as a starting point to determine whether criteria can be developed to select orofacial pain patients for MRI.

Results

During the study period (July 2012 to July 2016), 125 patients referred to the orofacial pain clinic underwent MRI scanning to aid the diagnosis of their orofacial pain condition. Thirty-four were male and 91 were female, and their mean age was 50 ± 12.0 years (range 19–77 years). The reported MRI pathologies in these patients included space-occupying lesions (three patients, 2.4%), trigeminal neurovascular contact at the transition zone (28 patients, 22.4%), and other pathologies unrelated to pain, including age-related changes such as vascular ischaemia and small vessel cerebrovascular disease (25 patients, 20%), pineal cyst (two patients, 1.6%), frontal or maxillary sinus pathology (two patients, 1.6%), and degenerative changes to the cervical spine (one patient, 0.8%). MRI features of demyelination were not found in any of the patients in this study. A normal appearance was seen in 64 patients (51.2%). Illustrative MRI images of a space-occupying lesion (schwannoma) and trigeminal neurovascular contact are shown in Figs 1 and 2.

Pain characteristics

The mean reported duration of pain on assessment at the orofacial pain clinic was 5 ± 6.7 years (range 0–44 years). The majority of patients, 80%, presented with unilateral pain (32.8% right-sided pain, 47.2% left-sided pain) and 20% reported bilateral pain. In patients whose pain was localized to one or more distributions of the trigeminal nerve (80 patients), the ophthalmic division (V1) was affected in 8.75%, the maxillary division (V2) in 35.0%, and the mandibular division (V3) in 17.5%. In the remainder of patients, multiple branches were affected: V1 and V2 in 11.25% of patients, V2 and V3 in

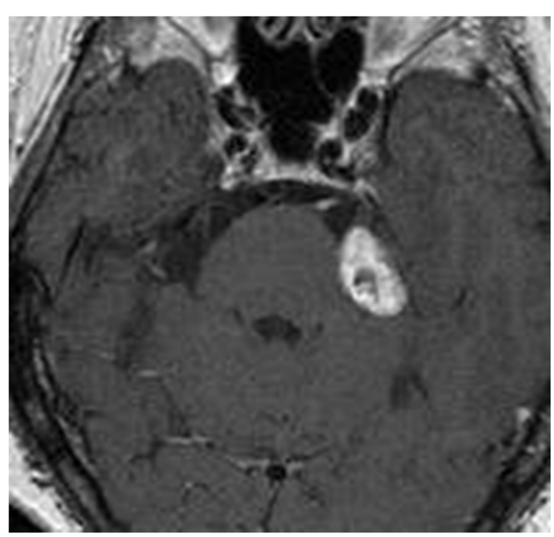


Fig. 1. Post-gadolinium T1-weighted axial image demonstrating a heterogeneously enhancing left cerebellopontine angle cistern schwannoma distorting the left cisternal trigeminal nerve.

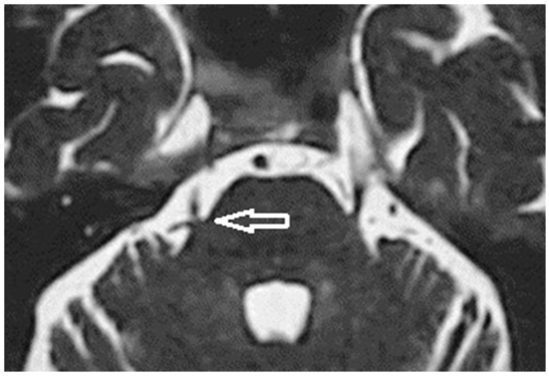


Fig. 2. T2-weighted CISS (Constructive Interference in Steady State) axial image demonstrating neurovascular contact at the right trigeminal nerve transitional zone immediately adjacent to the brain stem (arrow).

22.5%, and V1, V2, and V3 in 5.0% of patients. The provisional pain diagnoses prior to MRI scanning according to the primary complaint, frequency, and character of the pain are shown in Table 1.

Pain was reported to be spontaneous with no exacerbating or triggering factors in 68 (54.4%) patients in this group.

Previous MRI scan

Nineteen patients (15.2%) in this study had undergone a previous MRI scan for a suspected pathology. A new pathology was noted on repeat MRI scan in five of these cases (26.3%). This included three diagnoses of trigeminal neurovascular contact at the transition zone. One patient was referred for neurosurgery, one was not suitable for surgery due to age and co-morbidities and was referred to the pain management team, and the third patient declined any further treatment and therefore was discharged. One patient was diagnosed with a schwannoma and referred to neurosurgery and the final patient had enlargement of a pre-existing pineal cyst which was causing headaches. This patient was referred to neurology for further management.

Comparison of patients with positive and negative MRI findings

The study patients were divided into two groups depending on their MRI outcome: group 1 comprised those with a normal MRI (pathology unrelated to pain); group 2 comprised those with a space-occupying lesion, trigeminal neurovascular contact, or demyelination. Demographic data and the presenting symptoms were compared between the two groups.

Comparing male and female patients, 22 (24.2%) female patients had abnormal MRI findings compared with nine (26.5%) male patients. The mean age of patients with abnormal MRI findings was 51.0 years compared with 49.6 years for those with no pain-related pathology; this was not statistically significant ($P > 0.05$).

In patients whose pain could be localized to one or more divisions of the trigeminal nerve, patients were more likely to have abnormal MRI findings if pain affected multiple divisions (38.7%) in comparison to a single division (22.4%); however, this difference was not statistically significant ($P > 0.05$). There was no significance in which division of the trigeminal nerve was affected by pain.

With regard to pain characteristics, intermittent pain was more frequently associated with abnormal MRI findings than constant pain (35.9% vs. 19.0%). The mean duration of pain on presentation to the orofacial pain clinic was 5.18 years in the abnormal MRI group in comparison with 4.92 years in the normal MRI group. Neither of these findings was statistically significant ($P > 0.05$).

Figure 3 shows a comparison of patients with normal (group 1) and abnormal (group 2) MRI findings for each provisional diagnosis. Of the 35 patients with recurrent, unilateral, severe, and short duration attacks of pain, such as those with a provisional diagnosis of trigeminal neuralgia, glossopharyngeal neuralgia, or trigeminal autonomic cephalalgia, 14 had abnormal MRI findings (40%). Of the 90 patients without these presenting symptoms, 17 had abnormal MRI findings (18.9%). This difference was statistically significant ($P = 0.021$). The one patient with a provisional diagnosis of atypical odontalgia did have trigeminal neurovascular contact on the MRI scan; however it was thought that this was a chance finding. The frequency of MRI findings for each provisional diagnosis is shown in Table 2.

The various exacerbating or triggering factors for pain were also compared between groups (Fig. 4). The only significant findings were that 50% (8/16) of patients with pain on touching the area had abnormal MRI findings compared with 21.1% (23/109) of those with no pain on touching the area ($P = 0.017$). Patients with spontaneous pain were more likely to have normal MRI findings (56/68, 82.4%) than those with elicited pain (38/57, 66.7%) ($P = 0.043$).

Patient outcomes following MRI scanning

The outcomes for all patients in this study are shown in Fig. 5.

Of those patients with findings of trigeminal neurovascular contact within the transition zone, five (17.9%) did not wish further treatment and were discharged, seven (25%) were managed using medication such as carbamazepine and pregabalin, two (7.1%) were referred to neurology for medical management, 10 (35.7%) were referred for a neurosurgical opinion, and the remaining four patients were referred to psychiatry services (3.6%), pain management services (3.6%), and other specialties (7.1%).

Of the three patients with space-occupying lesions, one patient had a pre-existing diagnosis of meningioma and the pain was managed using carbamazepine and one patient was diagnosed with a schwannoma and was referred to neurosurgery. The third patient was diagnosed with a pre-existing pineal cyst which had become larger and symptomatic; this patient was therefore referred for a neurological opinion.

Of the patients with pathology unrelated to pain such as age-related small vessel disease, small pineal cyst, and sinus pathology, 10 (33.3%) were discharged, 15 (50%) were referred to neurology for further management of their symptoms, two (6.7%) were referred to psychiatry services, one (3.3%) to ear, nose, and throat services for management of a sinus pathology, and two were lost to follow-up.

The majority of patients with normal MRI scans were referred to neurology for further management of their symptoms (24 patients, 37.5%). Nineteen patients (29.7%) were discharged and 10 (15.6%) were managed with medication including tricyclic antidepressants, lidocaine patches (Versatis 700 mg medicated plaster; Grünenthal GmbH, Aachen, Germany), and botulinum toxin injections (Botox (onabotulinumtoxinA); Allergan Ltd, Dublin, Ireland). Four patients

Table 1. Provisional diagnosis prior to MRI scanning[a].

Provisional diagnosis	Primary complaint	Pain frequency	Character	Frequency (patients)
New onset primary headache	Recurrent headache, unilateral or bilateral; not associated with any other features	Continuous/recurrent	Moderate pain, pressing, tightening	11 (8.8%)
Migraine	Recurrent unilateral headache associated with nausea, vomiting, photophobia, or phonophobia	Recurrent attacks lasting 4–72 hours	Moderate to severe, pulsating	15 (12.0%)
Trigeminal V2 and V3 migraine	Recurrent unilateral facial pain associated with nausea, vomiting, photophobia, or phonophobia	Recurrent attacks lasting 4–72 hours	Moderate to severe, pulsating	6 (4.8%)
Persistent idiopathic facial pain	Recurrent poorly localized facial pain, does not follow nerve distribution	Daily for at least 2 hours each day for >3 months	Variable mild/ moderate/severe, dull, aching	25 (20.0%)
Atypical odontalgia/ persistent dentoalveolar pain	Recurrent poorly localized oral pain, does not follow nerve distribution	Daily for at least 2 hours each day for >3 months	Variable mild/ moderate/severe, dull, aching	1 (0.8%)
Painful trigeminal neuropathy	Head and/or facial pain in the distribution of one or more branches of the trigeminal nerve caused by previous neural trauma	Variable continuous or intermittent	Variable mild/ moderate/severe; neuropathy of affected nerve	23 (18.4%)
Spontaneous neuropathic pain	Facial or oral pain caused by a lesion or disease of the somatosensory nervous system	Continuous or recurrent	Variable mild/ moderate/severe, may be accompanied by symptoms of neuropathy in the affected region	19 (15.2%)
Post-herpetic neuralgia	Unilateral head and/or facial pain persisting or recurring for at least 3 months in the distribution of one or more branches of the trigeminal nerve, caused by herpes zoster	Continuous pain	Variable moderate/ severe; neuropathy of affected nerve	1 (0.8%)
Trigeminal neuralgia	Recurrent unilateral pain limited to the distribution of one or more divisions of the trigeminal nerve	Recurrent attacks lasting seconds to 2 minutes	Severe, electric shock, sharp	21 (16.8%)
Glossopharyngeal neuralgia	Recurrent unilateral pain in the ear, base of the tongue, tonsillar fossa, and/or beneath the angle of the jaw	Recurrent attacks lasting seconds to 2 minutes	Severe, electric shock, sharp	1 (0.8%)
Trigeminal autonomic cephalalgia	Recurrent unilateral pain associated with autonomic symptoms (conjunctival injection, tearing, eyelid oedema, nasal congestion, rhinorrhoea, facial flushing, or sweating)	Recurrent attacks of short duration (seconds to minutes)	Severe, sharp, stabbing	13 (10.4%)

MRI, magnetic resonance imaging.
[a] Some patients had more than one provisional diagnosis. The International Classification of Headache Disorders, third edition, 2013.

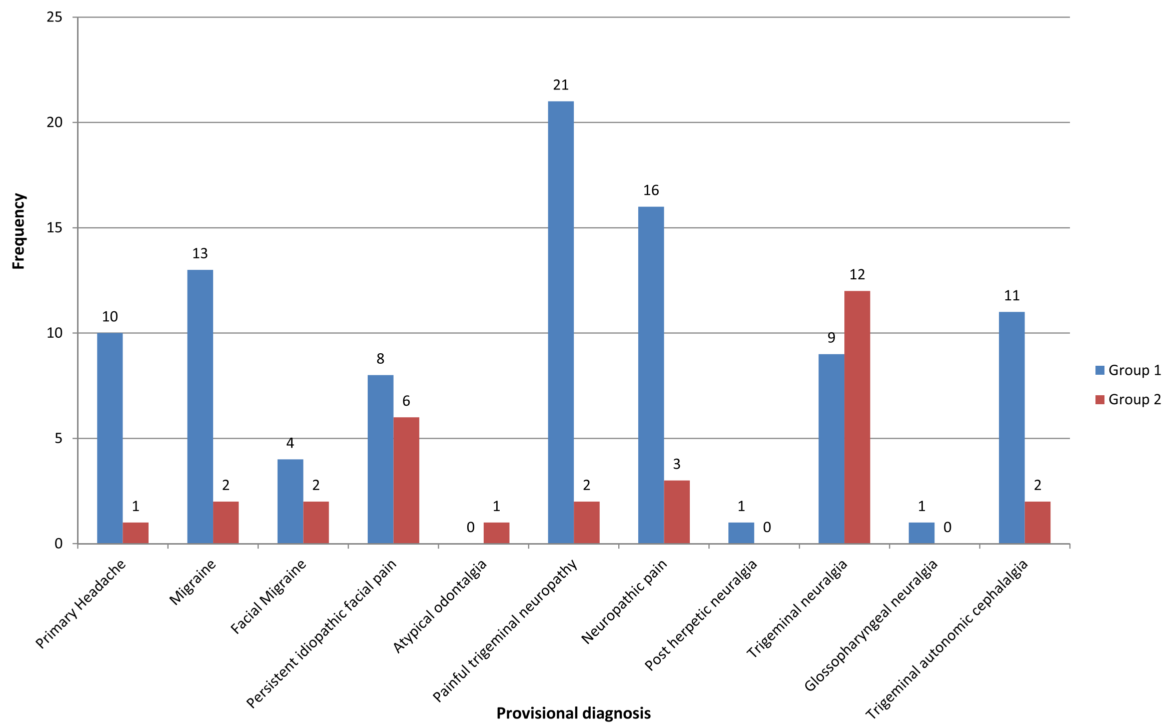


Fig. 3. Comparison of groups with normal (group 1) and abnormal (group 2) MRI findings for each provisional diagnosis.

Table 2. Findings on MRI scanning for each provisional pain diagnosis.

Provisional diagnosis	MRI findings			
	No abnormal findings	Pathology unrelated to pain	Space-occupying lesion	Trigeminal neurovascular contact
Primary headache	4	6	0	1
Migraine	9	4	1	1
Facial migraine	3	1	0	2
Persistent idiopathic facial pain	7	1	0	6
Atypical odontalgia	0	0	0	1
Painful trigeminal neuropathy	14	7	0	2
Neuropathic pain	11	5	0	3
Post-herpetic neuralgia	1	0	0	0
Trigeminal neuralgia	5	4	2	10
Glossopharyngeal neuralgia	1	0	0	0
Trigeminal autonomic cephalalgia	9	2	0	2

MRI, magnetic resonance imaging.

(6.3%) were referred to psychiatry services for cognitive behavioural therapy, three patients (4.7%) were referred to the pain management team, and two (3.1%) were referred to other specialties such as ear, nose, and throat surgery. Two patients were lost to follow-up.

Did MRI result in a change in diagnosis or management?

Pathology found on MRI scanning led to a change of diagnosis in 20 of 125 patients (16%). The provisional diagnoses of persistent idiopathic facial pain and atypical odontalgia were most likely to be associated with unexpected abnormal MRI findings (Table 3). In these cases, additional management included referral to neurology or neurosurgery for an opinion on the significance of the MRI findings and whether a surgical intervention was indicated. Without the MRI scan, these patients would have continued to be managed with medication only.

Discussion

This study provides data on the presence of intracranial pathologies diagnosed by MRI scan in a sample of patients presenting with a number of orofacial pain conditions over a 4-year period. A study by Ogütcen-Toller et al. diagnosed neurovascular compression of the trigeminal nerve in 39.5% and space-occupying lesions in 15.7% of patients undergoing MRI scanning for orofacial pain[10]. These percentages of diagnosed pathology are higher than those in the present study sample. However, the previous study only selected patients who had not responded to medical management of pain for MRI scanning, and therefore this may represent a more high-risk sample of patients. A study look-

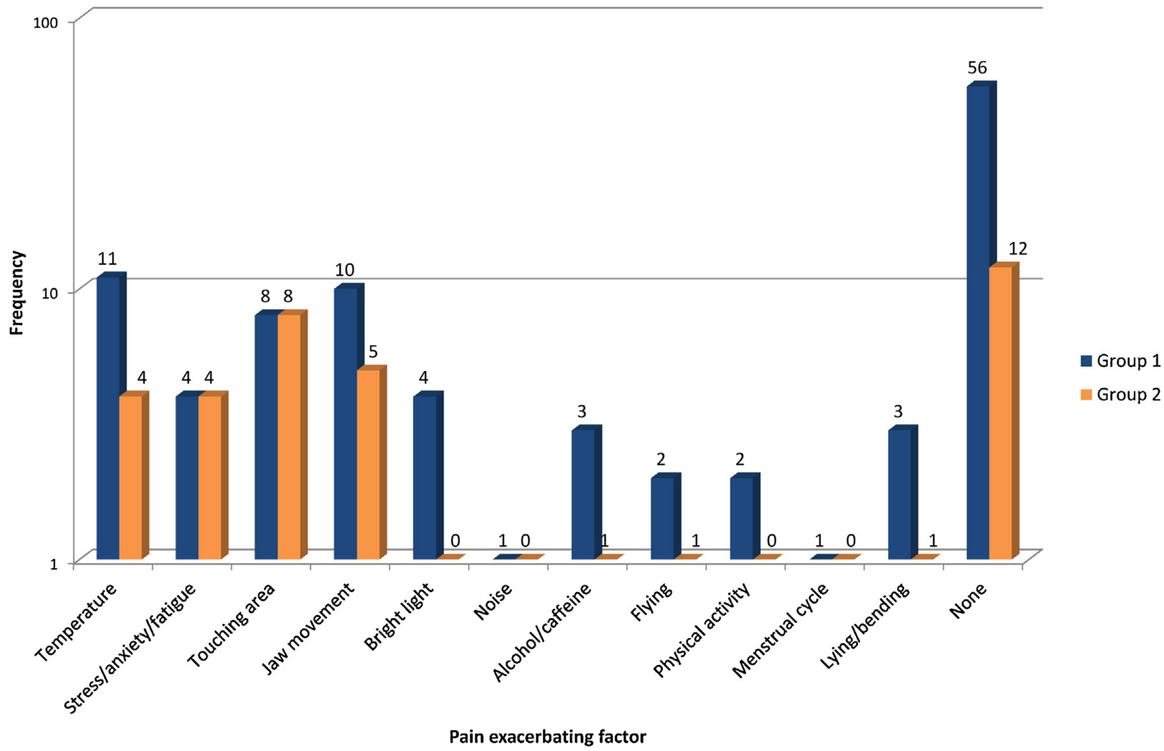
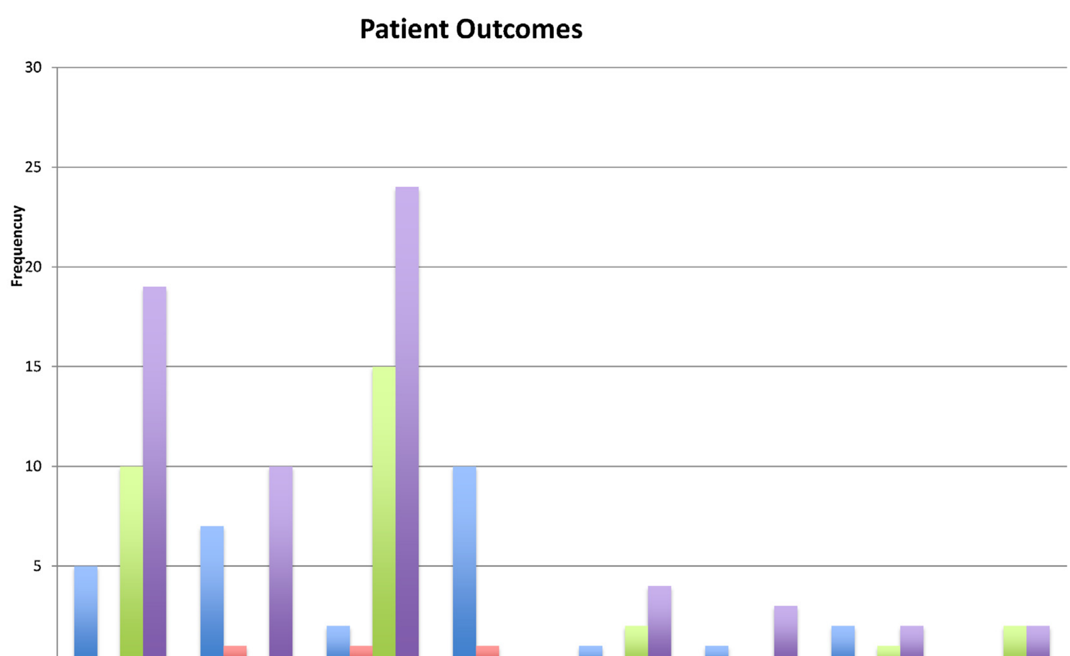


Fig. 4. Exacerbating factors for pain as reported by patients. Comparison between patients with normal (group 1) and abnormal (group 2) MRI findings.



	Discharge	Medical management	Referral: Neurology	Referral: Neurosurgery	Referral: Psychiatry	Referral: Pain Management	Referral: Other	Lost to follow up
Neurovascular contact	5	7	2	10	1	1	2	0
Space occupying lesion	0	1	1	1	0	0	0	0
Pathology unrelated to pain	10	0	15	0	2	0	1	2
Normal	19	10	24	0	4	3	2	2

Fig. 5. Patient outcomes following MRI scanning.

Table 3. Frequency of MRI pathology and change in diagnosis based on MRI findings for each provisional diagnosis.

	MRI pathology related to pain (%)	No MRI pathology related to pain (%)	MRI pathology led to change in diagnosis (%)
Primary headache	1 (9.1)	10 (90.9)	1 (9.1)
Migraine	2 (13.3)	13 (86.7)	1 (6.7)
Facial migraine	2 (33.3)	4 (66.7)	2 (33.3)
Persistent idiopathic facial pain	6 (42.9)	8 (57.1)	6 (42.9)
Atypical odontalgia	1 (100)	0 (0)	1 (100)
Painful trigeminal neuropathy	2 (8.7)	21 (91.3)	2 (8.7)
Neuropathic pain	3 (15.8)	16 (84.2)	3 (15.8)
Post-herpetic neuralgia	0 (0)	1 (100)	0 (0)
Trigeminal neuralgia	12 (57.1)	9 (42.9)	2 (9.5)
Glossopharyngeal neuralgia	0 (0)	1 (100)	0 (0)
Trigeminal autonomic cephalalgia	2 (15.4)	11 (84.6)	2 (15.4)
Total	31 (24.8)	94 (75.2)	20 (16)

MRI, magnetic resonance imaging.

ing at patients diagnosed with trigeminal neuralgia found space-occupying lesions to be present in 14.3%[11], and a review of the literature found that for patients with a diagnosis of trigeminal neuralgia, routine MRI may identify a cause (multiple sclerosis or tumour) in up to 15% of patients[12].

Several authors have suggested the following high-risk features of patients diagnosed with trigeminal neuralgia that would necessitate an MRI scan: young age, poor response to medication, atypical pain history, and clinical features such as bilateral pain, involvement of multiple trigeminal nerve divisions, and other cranial nerve abnormalities[13–15]. However, Goh et al. found no significant differences in demographic data, pain history, or response to medication between groups of patients diagnosed with trigeminal neuralgia with and without space-occupying lesions on MRI scan[11]. In the present study, factors significantly associated with positive intracranial findings on MRI scan included elicited pain, pain on touching the affected area, and a provisional diagnosis of trigeminal neuralgia or trigeminal autonomic cephalalgia. Nevertheless, Ogütcen-Toller et al. found it was not possible to reliably identify high-risk patients for MRI on the basis of a clinical evaluation alone[10]. Therefore if selection criteria were applied to this group of patients, a number of potentially significant intracranial lesions could be missed.

The first-line treatment for patients with trigeminal neuralgia is the use of carbamazepine or oxcarbazepine; however these medications are poorly tolerated or ineffective in controlling pain in some patients[16]. The pathophysiology of trigeminal neuralgia involves a complex interaction of peripheral and central mechanisms. Vascular compression causing focal demyelination of the trigeminal sensory root generating spontaneous ectopic impulses is thought to be responsible for the short-lasting spontaneous attacks of pain[17]. MRI scanning in patients with trigeminal neuralgia allows the identification of cases of neurovascular compression of the trigeminal nerve amenable to surgical management such as microvascular decompression. The success rate of this procedure in eliminating pain and the need for lifelong medication is high (83.5%)[18].

The diagnostic criteria given in the *International Classification of Headache Disorders Third Edition (Beta Version)* (ICHD 3-beta) for SUNCT (short-lasting unilateral neuralgiform headache attacks with conjunctival injection and tearing), SUNA (short-lasting unilateral neuralgiform headache attacks with cranial autonomic symptoms), and trigeminal neuralgia overlap significantly, making diagnosis complex[19]. Although the majority of SUNCT/SUNA cases are idiopathic, they have been reported to be secondary to intracranial pathologies such as pituitary adenoma, or vascular pathologies such as dissection[20]. There is also evidence that vascular compression of the trigeminal nerve at the root entry zone ipsilateral to the side of pain occurs in SUNCT and SUNA cases, which may be amenable to microvascular decompression of the trigeminal nerve[21]. It is therefore important to obtain MRI images in these cases to aid diagnosis and management.

A study of MRI findings in patients with persistent idiopathic facial pain found a high prevalence of neurovascular contact with the trigeminal nerve in 78% of patients. However, there was no correlation between the finding of neurovascular contact and clinical symptoms in persistent idiopathic facial pain patients. In contrast, findings of severe neurovascular contact in patients with a diagnosis of trigeminal neuralgia did have a strong association with the symptomatic side[22]. MRI scanning in these patients can aid surgical planning and consent for surgical intervention to manage the pain. Previous studies have reported nerve–vessel contact on MRI in 27% of asymptomatic patients[6]. It is therefore important to correlate the MRI findings with the clinical history and examination prior to recommending any invasive treatment.

Patients with migraine do not typically require MRI scanning. A meta-analysis of studies showed abnormalities in only 0.18% of patients with typical frequency episodic migraine without any abnormality on neurological examination[23]. However, patients with poorly controlled migraine or an increasing frequency of migraine may require referral to a neurologist for further management. Migraine with aura has been shown on MRI scanning to be associated with subclinical white matter abnormalities and infarct-like lesions that correlate with the number and duration of migraine attacks with aura. However, further longitudinal studies are required to assess their clinical significance[24].

From a patient perspective, a negative MRI scan alleviates anxiety related to unexplained symptoms that have been undiagnosed by clinicians until their referral to a facial pain clinic, providing some degree of therapeutic support, but it is not easily accessible for many clinicians or patients. From a clinical point of view, patients have often been assessed by multiple clinicians from multiple medical and surgical specialties due to the difficulty in establishing a facial pain diagnosis. MRI, which is free of ionizing radiation and relatively low in cost, can reduce these unnecessary appointments and indicate appropriate referral and treatment when required. However, MRI scanners require patients to be fully enclosed within the scanner, which can lead to claustrophobia and restricts the availability of scanning for bariatric patients[25].

In conclusion, this study found that patients with provisional diagnoses of trigeminal neuralgia or trigeminal autonomic cephalalgia, as well as patients with elicited pain, were more likely to have abnormal findings on MRI scanning.

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Competing interests. No conflict of interest.

Ethical approval. The study was performed using the service evaluation design approved by the local hospital audit committee at King's College Hospital.

Patient consent. Not required.

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