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Main Article

The compliance, true positive and false negative rates of the Charing Cross protocol for magnetic resonance imaging screening for cerebellopontine angle lesions

J D Snelling, M Krywawych, A Majithia, J P Harcourt

Abstract

Objectives: To assess the effectiveness and determine the compliance to a local protocol for requesting magnetic resonance imaging scans to screen for the presence of cerebellopontine angle lesions.

Methods: A combined retrospective study of all patients who had magnetic resonance imaging scans requested six months prior to and one year following introduction of the protocol and assessment of the true positive and false negative rate of the protocol by assessment of its sensitivity in cases referred from outside the department.

Results: Comparison of the number of scans in each period showed a reduction in annualised rate of 142 to 46. The incidence of positive scans was the same in both periods, increasing the true positive rate from 1.4 to 4.3 per cent. The false negative rate was 1.1 per cent.

Conclusions: The Charing Cross protocol has a good compliance rate within the department, has reduced the cost of screening for cerebellopontine angle lesions and has an acceptable true positive and false negative rate.

Key words: Acoustic Neuroma; Magnetic Resonance Imaging; Diagnosis; Audiometry, Pure-Tone

Introduction

The vast majority of cerebellopontine angle lesions are vestibular schwannomas. The non-vestibular schwannoma lesions include non-VIIIth nerve schwannomas, meningiomas, congenital cholesteatomas and glomus tumours. All these lesions are benign and usually slow growing, although very rarely malignant lesions can present in this anatomical space usually as a metastasis, and should not alter the predominantly conservative approach to diagnosis (potential long waiting time to scanning and non-treatment options after diagnosis). The most usual presentation of a vestibular schwannoma, as the characteristic form of a cerebellopontine angle lesion, is a gradual unilateral progressive hearing loss (90 per cent), which usually affects the high frequencies. A small number will present with a sudden hearing loss (10 per cent). Five per cent of vestibular schwannomas are bilateral and associated with neurofibromatosis type 2. The most accurate diagnostic test for vestibular schwannoma is the magnetic resonance imaging (MRI) scan. Whilst vestibular schwannomas are rare, unilateral hearing loss is relatively common. The National Study of Hearing has shown that as many as 10.4 per cent of the population has an asymmetric hearing loss affecting the high frequencies. A large proportion of clinic attendees (19.7 per cent)[1] could have a vestibular schwannoma and would benefit from an early diagnosis. This may be for the purposes of careful monitoring in the context of a watch and wait policy,[2] or for the benefit of reduced operative morbidity if the chosen initial management is surgery.[3] Diagnosing vestibular schwannomas can be an expensive and labour intensive process with poor yield because of the frequency of patients presenting with compatible symptoms and signs to the out-patient clinic.

In the otolaryngology department at the Charing Cross Hospital work has been done to devise a simple but safe and effective protocol of patient selection for scan referrals (Appendix I).[4] The protocol, drawn up from analysis of previous positive scan results and the review of other published protocols, utilises the fact that interaural asymmetry in bone conduction thresholds is almost invariably present in vestibular schwannomas. It utilises an optimal combination of sensitivity (97 per cent) and specificity (49 per cent).

All these patients had their audiographic thresholds recorded at octave intervals from 250 Hz to 8 kHz. For patients with no reliable response at the equipment limits of the audiometer, an arbitrary

From the Department of Otolaryngology, Charing Cross Hospital, London, UK.
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threshold was assigned of 5 dB higher than the maximum output of the audiometer at that frequency. Bone conduction thresholds were used to judge asymmetry when there was an air–bone gap of greater than 10 dB. The thresholds for 250 Hz and 8 kHz, where bone conduction thresholds were not measured, were estimated by the trend in air conduction and bone conduction thresholds at the other frequencies.

Regardless of audiometry, further imaging was warranted if other symptoms or signs indicated intracranial pathology.[5] These included presentation with acute sensorineural hearing loss, non-VIIIth nerve cranial nerve deficit, persistent disequilibrium or an unresolving headache. Unilateral tinnitus is not considered an indication for screening. In a series of 546 patients with a diagnosis of vestibular schwannoma, Lustig found only four cases with symmetrical hearing and asymmetric tinnitus.[5] As this is a rare presentation of a benign and often non-progressive disease, we do not feel it warrants the increase in imaging.

This paper reports a retrospective review of the effects on rates of imaging of the introduction of the protocol as well as the outcome of the investigation (true positive rates). We also analysed the false negative rate of the protocol on the patients referred to our department with a pre-existing diagnosis of a cerebellopontine angle lesion.

Methods

Following the definition of a protocol for referral for MRI scanning, the protocol was widely advertised within the department and guidelines as to which patients should be referred for a scan were circulated amongst staff and displayed in each clinic room within the ENT out-patient department.

This retrospective study examines the impact of this protocol on the referral patterns for MRI imaging. The review period included the six months before and one year after the implementation of the protocol. In order to counter the effects of lag-time error, a list of all patients who had MRI scans requested in the audit period was compiled from the radiology department database. All available notes were pulled and pertinent data collected. The notes were reviewed for the age, sex of the patient, MRI scan findings and indication for scanning. Indication for scanning included audiovestibular symptoms, for example hearing loss, tinnitus, vertigo or other symptoms. MRI request dates and actual scan date were also noted. Pure tone audiometry was recorded for both groups of patients. When bone conduction was available this was recorded, otherwise air conduction was recorded from pure tone audiograms. We also looked at whether the request was made by the ENT department and the grade of the doctor that had made the request for the MRI scan. All patient notes were assessed to see whether the request was protocol concordant.

We excluded patients from the audit who had scans to follow up known vestibular schwannomas and those that had been referred from audiological medicine and neurosurgery since these doctors did not utilise the scanning protocol.

The majority of cases of cerebellopontine angle lesions within the departmental database are tertiary referrals and therefore not from departments limiting their imaging by protocol. These cases were all assessed by the protocol to calculate a false negative rate for the protocol.

TABLE I

COMPARISON OF THE PRE- AND POST-PROTOCOL AUDIT GROUPS

		Pre-protocol (%) (6 months)	Post-protocol (%) (1 year)
Sex	Male	48.0	52.2
	Female	52.1	47.8
Side	Right	43.7	39.1
	Left	53.5	56.5
	Not stated	2.8	4.3
Requester	Consultant	31.0	28.3
	Specialist registrar	42.3	52.2
	Senior house officer	26.7	19.6
Hearing loss	Yes	83.1	91.3
	No	16.9	8.7
Tinnitus	Yes	59.2	47.8
	No	40.8	52.2
Vertigo	Yes	26.8	34.8
	No	73.2	65.2
Bilateral loss	Yes	16.9	32.6
	No	83.1	67.4

Results

A total of 117 MRI requests, scans, audiograms and patient's notes were analysed. Seven sets of notes were missing. The number of requests for MRI of the internal auditory meati was reduced from 71 in six months (annual rate of 142 scans) to 46 scans in the subsequent year. A comparison of the review groups is shown in Table I.

The diagnoses from the scans were reviewed. Prior to the protocol, there was one vestibular schwannoma, one frontal lobe mass, six scans demonstrated cerebral vascular disease and there were 63 normal scans (true positive rate of 1.4 per cent). Post protocol there were two vestibular schwannomas, one demyelination, one inflamed geniculate ganglion, seven showing cerebral vascular disease and 35 normal scans (true positive rate of 4.3 per cent). (Table II).

Scan requests following the protocol were assessed for compliance to the protocol and subdivided by

TABLE II

MRI SCAN DIAGNOSES OF STUDIED PATIENTS

Diagnosis	Pre-protocol (6 months)	Post-protocol (1 year)
Normal scan	63	35
Vestibular schwannoma	1	2
Cerebral vascular disease	6	7
Frontal lobe mass	1	0
Inflamed geniculate ganglion	0	1
Demyelination	0	1

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TABLE III

CONCORDANCE TO PROTOCOL BY THE REQUESTER'S GRADE

Concordance	Consultant ($n = 13$)	Specialist registrar ($n = 24$)	Senior house officer ($n = 9$)
Positive	76.9%	70.8%	88.9%
Negative	23.1%	29.2%	11.1%

grade of requester (Table III) and division of the protocol, i.e. unilateral or bilateral hearing loss (Table IV). A total of 35 out of 46 scan requests were protocol compliant.

Of the 11 scans that were not protocol concordant, one patient had a past history of a meningioma in their lumbar spinal cord and one was requested within two weeks of the protocol introduction. Two patients had facial nerve palsy and one described altered sensation in the distribution of the ophthalmic nerve. Of the six remaining non-compliant requests, there were no extenuating reasons, nor was any particular individual requesting the scans.

The senior author (JH) identified 102 patients with cerebellopontine angle lesions from the departmental database. Fifteen of these were diagnosed at the Charing Cross Hospital and 87 were referred from other centres. Of these patients, six were not consistent with the audiometric criteria. Three of these patients presented with trigeminal paraesthesia and one with persistent ataxia and would therefore have been scanned on the basis of their neurological signs. Of the remaining two, one patient had acute sensorineural hearing loss with subsequent recovery of hearing and was scanned because of the acute sensorineural hearing loss. Only one patient was non-compliant on all grounds. She presented with unilateral hearing loss (below criterion threshold) and bilateral tinnitus. Subsequent scanning demonstrated a 3 mm intracanalicular vestibular which to date has been managed conservatively. This makes a false negative rate of 1.1 per cent.

Discussion

The general indications for any screening programme include a few critical criteria. Firstly, there must be health implications or treatment options following the making of a diagnosis. There is debate about how best to manage vestibular schwannoma,[2,3] but whether the decision is surgery or monitoring with sequential scans, there is treatment to prevent disease progression either acutely or as a timely intervention. Magnetic resonance imaging currently stands as the gold standard diagnostic test, sensitive and specific enough to diagnose even small retrocochlear lesions. Magnetic resonance imaging itself is a non-invasive test that is tolerated well by all but a few patients. It is currently the investigation of choice in those suspected of vestibular schwannoma.

TABLE IV

CONCORDANCE TO PROTOCOL BY DIVISION OF THE PROTOCOL

Concordance	Unilateral hearing loss ($n = 31$)	Bilateral hearing loss ($n = 15$)
Positive	71.0%	80.0%
Negative	29.0%	20.0%

The issue of cost-effective screening using MRI is international and has been around for a number of years.[6,7] It has been determined that 19.7 per cent of referrals to a district general ENT department are candidates for a potential vestibular schwannoma. This presents a huge potential burden on both financial and radiological resources.[1] The number of scans requested can be reduced by the introduction of a safe (sensitive) but regulated (specific) protocol of indications for scanning patients with potential vestibular schwannomas. A reduction in the number of scans not only impacts upon the cost but also the amount of available scanning time and therefore waiting times.

The protocol used in the otorhinolaryngology department at the Charing Cross Hospital was devised following an audit of all MRI scans of the internal auditory meati at the Charing Cross Hospital and St Bartholomew's Hospital in 2000. Potential and pre-existing published protocols were tested against this population to define sufficiently sensitive and specific criteria for a department policy.[4]

Our audit has demonstrated that the number of scans has been dramatically reduced since the introduction of the protocol. This has enormous cost implications in managing patients presenting with audio-vestibular symptoms and screening for a benign disease, whose management has become increasingly conservative with the recognition of the slow or non-growth of the lesions and the potential morbidity and loss of quality of life with treatment. Avoiding scanning alleviates the anxiety of the wait for the test, the test itself and the wait for the result.

- **Diagnosing vestibular schwannomas can be an expensive and labour intensive process with poor yield**
- **Potential and pre-existing published protocols were tested against a population of diagnosed vestibular schwannoma patients to define sufficiently sensitive and specific criteria for a department policy**
- **Our audit has demonstrated that the number of scans has been dramatically reduced since the introduction of the protocol**
- **The false negative rate of the protocol derived by assessing non-protocol diagnosed patients suggests that the sensitivity of the test is satisfactory**

Amongst those scans requested, there is reasonable compliance with the protocol. Amongst the different grades of surgeon, the specialist registrars

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had the lowest non-compliance rate of 70.8 per cent ($n = 34$). This may relate to the fact that specialist registrars made the majority of requests or to an attitude of increased caution. To our surprise, most of the non-compliant scans were in patients with unilateral hearing loss whilst the protocol was well applied in the potentially more complex cases of bilateral hearing loss.

The assessment of the false negative rate of the protocol by assessing non-protocol diagnosed patients suggests that the sensitivity of the test is satisfactory, although the gold standard for such modelling would be to scan all patients presenting with audio-vestibular symptoms to our department so that the true incidence could be assessed. At present the costs and ethical issues of putting large numbers of patients through an unnecessary test make this unachievable.

For a protocol to be effective it needs to be utilised rigorously. Staff require reminders and new and locum staff need to be informed on commencing their work. We have closed one cycle of the audit loop and demonstrated that the protocol applied at the Charing Cross Hospital is straightforward to apply and interpret. Further work should be done to verify the efficacy and evaluate the utilisation of the protocol some time following the immediate impact of its introduction.

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Appendix I.

PROTOCOL

An MRI scan of the internal auditory meati is indicated in:-

Unilateral Hearing Loss

Difference in bone conduction threshold of >15 dB in two adjacent frequencies

or

Bilateral Hearing Loss (Better Ear has mean threshold ≥30 dB)

Difference in bone conduction threshold of >20 dB in two adjacent frequencies

or

Unilateral Tinnitus

Only if >10 dB difference in 50% speech discrimination score

or

Non VIIIth nerve symptoms/signs

Address for correspondence:
James D Snelling,
9 West Hill,
Sanderstead,
South Croydon,
Surrey, CR2 0SB, UK.

Fax: 44 (0)20 8657 2741
E-mail: jamesdsnelling@hotmail.com

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