

A cost effective screening protocol for vestibular schwannoma in the late 90s

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Abstract

Magnetic resonance imaging (MRI) is the imaging modality of choice in diagnosing vestibular schwannoma (VS). Perceived high costs have prevented clinicians from using it as a screening investigation, although MR scanners are now widely available in the United Kingdom. In a retrospective study, the clinical records of all the patients who presented to the ENT department of Taunton and Somerset NHS Trust with suspected symptoms of VS during the year 1994 were analysed. The cost of confirming or refuting the diagnosis of VS in each patient ranged from £220.72 to £580.31 depending on the number of hospital visits and investigations performed. This study shows that the routine use of MR scanning for detection of VS is cost effective and more effective than the use of conventional tests.

Key words: Magnetic resonance imaging; Vestibular schwannoma; Cost benefit analysis

Introduction

Magnetic resonance imaging (MRI) is accepted as the most sensitive and specific investigation currently available in diagnosing vestibular schwannoma (VS). Although most hospitals in the UK have access to this facility it is still used only after a battery of investigations have been carried out. The reluctance of clinicians to use MRI as a screening investigation is based on a false premise of economy relating to other conventional tests. In our department at Taunton and Somerset NHS Trust patients with a clinical history and pure tone audiometry suggestive of a retro-cochlear lesion are investigated further with MRI. In this study the cost of various investigations used in the diagnosis of VS are analysed and evidence to suggest that the above protocol is cost effective and clinically desirable is presented.

Materials and methods

During twelve month period (January 1994 to December 1994) 100 requests for MRI were made as part of the investigation to exclude a VS in 100 patients from the ENT department of Taunton and Somerset NHS Trust. In a retrospective study the clinical records of these patients were analysed. This included a review of symptoms, investigations performed, the time lapse between the patient first presenting to the clinician to the time MRI scan was requested and the number of visits to the ENT outpatient department during this period. The cost of confirming or refuting the diagnosis of VS in each patient was then derived by calculating the cost of

outpatient visits and the investigations performed in each case (Table I). The cost of an MRI scan in diagnosing VS at the Taunton and Somerset NHS Trust was compared with that of the NHS Trusts of Exeter and Plymouth to identify any regional variations. The NHS Trusts at Taunton, Exeter and Plymouth are similarly sized and are all in the southwest region of the United Kingdom.

Results

In the 100 MRI scans performed during the 12-month period, three tumours were identified. Two

TABLE I
COSTS INVOLVED IN DIAGNOSIS OF VESTIBULAR SCHWANNOMA AT
TAUNTON AND SOMERSET NHS TRUST

Investigation	Cost (£)
First appointment	75.00
Each review appointment	38.00
Pure tone audiometry	8.72
Technician time 35 mins	5.25
Overhead and consumables	3.47
Special audiological tests (Speech, recruitment, decay)	24.90
Technician time 1 h 40 mins	15.00
Overhead and consumables	9.90
Electronystagmography	48.97
Senior Audiologist	
Testing -1 h	9.00
Reporting -1.5 h	13.50
Nurse -1 h	7.00
Overhead and consumables	19.47
CT scan with contrast	125.00

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TABLE II
PRESENTING SYMPTOMS IN 100 PATIENTS WITH SUSPECTED
VESTIBULAR SCHWANNOMA

Symptoms	Number and %	Only symptom
Asymmetrical hearing loss*	89	18
Tinnitus	63	2
Vertigo	32	2
Pain behind ear	3	0
Sudden hearing loss	4	3
Fullness/otalgia	4	0
Facial palsy	2	1

*The three patients with AN presented with this symptom.

were treated surgically and the other was managed conservatively.

Table II shows the symptoms with which the patients presented to the clinician. Most patients presented with asymmetric hearing loss and in 18 percent of them, this was the only symptom. All the three patients with VS presented with this symptom and in two this was the only symptom.

When patients with clinical history and pure tone audiometry suggestive of a retrocochlear lesion were sent for MR scanning as their next investigation, the cost per patient was £220.72 if the result was communicated to them through their general practitioner. If the result was discussed with the patient in a further outpatient visit, the cost increased to £258.72. As the number of outpatient visits and investigations increased, the cost reached £580.31 per patient. Table III shows the number of outpatient visits, investigative procedures, time lapse before diagnosis and cost per patient. It was apparent that the number of outpatient visits prior to requesting the MRI scan was greater if patients were routinely followed up in a senior house officer or registrar clinic. This implies that junior doctors may be more reluctant to request expensive investigations without seeking advice from the consultant. Interpretation of mild asymmetry in the audiograms and correlating otoscopy findings with pure tone audiograms comes with experience and where doubt exists the junior doctor should be encouraged to discuss the case with the consultant.

TABLE III
CLINICAL INVESTIGATIONS

Number of outpatient visits	Investigations performed	Number of patients	Average time elapsed before MRI scan	Approx cost/patient prior to discharge/referral (£)
1	Pure tone audiogram	3	3 months	220.72
	MRI			
2	Pure tone audiogram	44	12 months	258.72
	MRI			
4	Yearly pure tone audiogram	26	31 months	352.16
	MRI			
5	Yearly pure tone audiogram	12	42 months	398.88
	MRI			
4	Pure tone audiogram	11	38 months	417.31
	Special audiological tests			
	ENG, MRI			
5	Pure tone audiogram	4	38 months	580.31
	Special audiological tests			
	ENG, CR/MRI scan			

Table IV compares the MR scanning costs in three NHS Trusts in the southwest region of United Kingdom. In Plymouth and Taunton patients are screened in sessions and gadolinium diethylenetriamine-pentaacetic acid (Gd-DTPA) contrast is routinely used. In Exeter patients are not screened in sessions and contrast is used in only about two per cent of patients. The variations in cost are shown in Table IV. There has been more than a 50 per cent reduction in cost of an MRI scan in the last seven years from £295 to £137 at Taunton. Evoked response audiometry is not routinely used in investigating patients suspected of having a VS in Taunton and Somerset NHS Trust.

Discussion

Gadolinium-enhanced MRI has been available for about a decade and has proved to be the long awaited innocuous, definitive investigation for VS. Using this as a screening investigation is cost effective and more effective than the use of conventional tests.

Various screening protocols for VS have been suggested since the early eighties. The protocol favoured by Terkildsen and Thomsen (1983) was based on three investigations: ERA, tomography of the internal auditory meatuses and caloric testing. Patients with two positive results were submitted to computerized tomography (CT) scanning of the posterior fossa and if no abnormality was found, CT air meatography was carried out. Smith *et al.* (1990) suggested a 'weighted' system of scoring of the three investigations detailed above and the presence of neurological signs to avoid subjecting large numbers of normal patients to CT air meatography, a procedure associated with a significant morbidity. Swan and Gatehouse (1991) suggested that referring all patients with a suspected tumour for CT is less expensive than performing CT when one or both of ERA and electronystagmography and caloric tests are abnormal. They also suggested routine follow-up for all patients with abnormal responses on ERA but normal CT and further investigation if there was progression of hearing impairment or development of other neuro-

TABLE IV
COST OF MR SCANNING IN THE DIAGNOSIS OF VESTIBULAR SCHWANNOMA

	Exeter	Plymouth	Taunton
Cost of scanning one patient	£128.00	£110.00	£137.00
Screening in sessions	No	Yes	Yes
Routine use of contrast agent	No*	Yes	Yes
Additional cost per patient when contrast is used	£30.00	N/A**	N/A**
Cost per scan in 1989	Not available	Not available	£285.00

*Approximately 2 per cent of patients are given contrast.

**Not applicable because contrast agent was routinely used in Plymouth and Taunton and is included in the cost of scanning each patient.

logical signs. Welling *et al.* (1990) devised a practical decision tree for the diagnostic assessment of patients with VS. For patients with high and medium probability, i.e. patients presenting with unilateral sensorineural hearing loss or unexplained tinnitus, an MRI is requested as the first investigation. Patients presenting with symmetrical hearing loss, vertigo, explained hearing loss or tinnitus are classified as low probability and ERA is used as the first investigation. If ERA is positive these authors perform an MRI scan.

Screening can be applied to whole populations or to subgroups felt to be at greater risk. The general criteria for an effective screening programme are (Campbell and Royle, 1992);

- (1) The disease screened must be an important problem.
- (2) The natural history of the disease should be well understood with a recognizable early stage.
- (3) A specific and sensitive test for the early detection of the disease must be available.
- (4) There should be good evidence that the screening test can result in reduced mortality and morbidity in the targeted population.
- (5) There should be appropriate treatment options.
- (6) The benefits of screening must outweigh any adverse effects.

Renowden and Anslow (1993) and Robson *et al.* (1993) showed that using MRI as the sole investigation for sensorineural hearing loss, the cost of VS screening was between £70 and £130. There appears to be a variance in the cost of MR scanning even within the southwest region of the United Kingdom as seen in Table IV. The number of scans requested is likely to increase in the coming years but with efficient use of available scanner time and possibly increasing the number of scanners, the demand could be met. Phelps (1991), summarised the acceptable technique and advantages of MR scanning as a screening investigation for VS. Therefore techniques could be standardised and costs reduced.

Saeed *et al.* (1995) suggested a limited protocol MRI. This MRI protocol involved scanning between 10 and 12 patients per month in a one day session. Each examination takes up to 30 minutes and as the same test is performed for each case, recalibration of the MR unit is not required. Gadolinium DTPA contrast is used in half the quantity required for a conventional procedure thereby reducing costs. A

T2-weighted sequence examines the brain and craniocervical junction to exclude any other pathology such as demyelination or Arnold-Chiari malformation.

A reluctance of ENT surgeons to request 'expensive' investigations in the first instance may increase costs and adversely influence the outcome for the patient if a diagnosis is not made early. The rewards of early diagnosis and treatment of VS to the patient and to the community are well cited in the literature. Moffat *et al.* (1989) reported that the surgical outcome is directly related to the size of tumour at diagnosis – large tumours are associated with significantly higher morbidity and mortality than small tumours.

There is little defence for not suspecting an acoustic tumour in a patient with asymmetric sensorineural hearing loss that is otherwise unexplained. Subtle presentations will become more common as smaller tumours are found (Welling *et al.*, 1990).

Gadolinium-enhanced MRI is a very sensitive, specific, non-invasive and non-ionizing investigation. Patients with claustrophobia may prefer CT scanning but with adequate sedation most patients are able to tolerate the MRI scanner. MRI is contra-indicated in patients with aneurysm clips or pacemakers. Allergic reactions to gadolinium are extremely rare especially when compared with iodinated contrast agents. Gadolinium is contra-indicated in patients with haemolytic anaemia. Routine use of gadolinium for all patients is currently recommended (Phelps, 1991). However, gadolinium is likely to become a thing of the past as more refined imaging protocols come along. That too, of course, would bring down the cost further.

If a gadolinium-enhanced MRI scan is negative the patient can be strongly reassured. The shortcomings of all the other investigations used are well illustrated in the literature (Welling *et al.*, 1990). A cost-effective workup should bypass special audiological tests, ENG, CT and other conventional investigations which are shown to have a high false positive and false negative rate. To date there have been no reported false positive or false negative MRI scans when performed by an experienced radiologist using an appropriate technique.

Since a reliable investigation is now available, further improvement in the efficiency of VS diagnosis relies largely on the clinician maintaining a high index of suspicion of VS based on a familiarity

with its varied and often atypical presentation (Selesnick *et al.*, 1993).

It is known that tumour growth rates vary from patient to patient. Spontaneous tumour shrinkage has also been described (Jorgensen and Pedersen, 1994). Increased use of MRI is liable to detect small tumours which might never have caused problems. Hence caution is to be exercised against unnecessarily aggressive treatment protocols.

Conclusion

The routine use of MRI as a screening investigation for VS is cost-effective and more effective than the use of conventional tests. Every patient referred to an ENT surgeon for exclusion of VS needs a thorough ear nose and throat and central nervous system examination and pure tone audiometry. In case of doubt, the patient should be sent directly for MRI. This protocol compares favourably with the traditional line of investigations both in cost and patient acceptability.

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