Ann R Coll Surg Engl 1995; 77: 210–216

Functional outcome in patients after excision of extracanalicular acoustic neuromas using the suboccipital approach

N M Kane MSc FRCS[1]
Research Registrar

S Kazanas MD[2]
Visiting ENT Registrar

A R Maw MS FRCS[2]
Consultant Otolaryngologist

H B Coakham FRCS FRCP[1]
Professor of Neurosurgery

M J Torrens MPhil ChM FRCS[1]
Consultant Neurosurgeon

M H Morgan MA MD FRCP[1]
Consultant Clinical Neurophysiologist

G Stranjalis BA MD[1]
Neurosurgical Registrar

S R Butler MA PhD[3]
Scientific Director

[1] Frenchay Hospital, Bristol [2] ENT Department, Bristol Royal Infirmary
[3] Burden Neurological Institute, Bristol

Key words: Acoustic neuroma; Surgery Audit; Outcome

An audit of surgery for acoustic neuroma was carried out to determine the frequency and nature of post-operative symptoms and their impact upon the patient's quality of life and vocation. Fifty-six patients were interviewed between 6 months and 5 years (mean 26 months) after surgical excision of an acoustic neuroma. The objective surgical results in these patients are good, with normal or near normal functional preservation rates of 80% for the facial nerve (House–Brackmann grade I/II), and 27.3% for a previously functioning acoustic nerve. Despite this there was no significant overall reduction in the reported occurrence of balance problems, tinnitus, headache and other neurological sequelae of the tumour after surgical excision. In 20% of the patients persistent symptoms, including deafness and facial weakness, had prevented the resumption of former social activities. As a result of these symptoms 8.6% of the patients were certified medically unfit for work, but of those employed preoperatively over 70% had returned to their jobs. The success of neuro-otological surgical management of acoustic neuroma is offset by some degree of chronic morbidity. Our patients expressed the need to know whether their symptoms would resolve, but were often too afraid to ask. Patients can be reassured that the majority resume their former social and vocational activities, but should be advised that some symptoms can persist or occur *de novo* after surgery. Our data suggest that early intervention would reduce the incidence of these troublesome sequelae.

Present address: M J Torrens and G Stranjalis, Department of Neurosurgery, Ygeia Hospital, Athens, Greece

Correspondence to: Mr N M Kane, Department of Neurosurgery, Frenchay Hospital, Frenchay, Bristol, BS16 1LE

The outcome of open surgery for acoustic neuromas is improving. Tumour excision is now being achieved with satisfactory function of the facial nerve in the majority and of the acoustic nerve in a significant minority of cases *(1)*. However, concern has been expressed that the surgeon's view of a good result may not accord with that of their patients, a proportion of whom experience persistent symptoms *(2)*. While the early postoperative complications and serious morbidity have been widely evaluated, few studies have addressed the patient's long-term prospects of resuming social and vocational activities. Patients increasingly wish to participate in their clinical management and therefore need to know the expected outcome of treatment options. Where possible we must strive to provide information not only about the nature and risks of treatment, but also the likely symptomatic and functional consequences of it.

The groups that have investigated the symptomatic and

socioeconomic consequences of acoustic neuroma and its surgical management, report varying incidences of residual physical, psychological and/or occupational impediments *(3–6)*. Two of these patient surveys analysed self-administered postal questionnaires, with response rates of 65% *(3)* and 93% *(4)*; one group interviewed patients *(5)*, while another reviewed the state pension registry *(6)*. If 'return to vocation' is considered as an index of functional recovery, one clinical review revealed that 21 (38%) of 55 surgically treated acoustic tumour patients had to discontinue work after their operation *(5)*, compared with 7% *(3)*, 13% *(4)* and 33% *(6)* in other studies. This suggests heterogeneity in the patient populations or a sampling error and, unfortunately, since variables such as tumour size, surgical approach and monitoring techniques are not always clearly stated, it is uncertain what gives rise to such variation.

We have interviewed an unselected, consecutive series of patients with acoustic neuromas who were operated on by the same team, using a standard surgical approach and monitoring technique described previously *(1)*. There are distinct advantages of questionnaires administered by interviewers *(7)*, and this approach enabled a 97% response rate in our surviving population. Furthermore, detailed information on tumour size, preoperative status and perioperative course was known in this group of patients.

Patients and methods

Between March 1988 and February 1993 a total of 63 operations was performed at Frenchay Hospital, Bristol, in a consecutive series of 61 patients with acoustic neuromas (two patients had neurofibromatosis with bilateral tumours and staged, bilateral operations). Surgery was performed in the neurosurgical department of Frenchay Hospital, Bristol, by a neurosurgeon (MJT or HBC) and an ENT surgeon (ARM) using the suboccipital approach.

In June 1993 a letter invited patients to attend a special clinic, which was conducted by two clinicians who administered a structured questionnaire and invited comment. The investigators (a visiting ENT surgeon (SK) and a research registrar (NMK)) were not involved in the surgical management, and assured the patients of confidentiality and impartiality. The disease-specific questionnaire, adapted from Wiegand and Fickel *(3)*, contained 55 questions about pre- and postoperative symptoms, coping with treatment and return to activities after surgery. During the 5-year follow-up period three patients had died (two from unrelated causes) and two patients, who were lost to follow-up, did not attend. Information has been analysed from the remaining 56 patients (Table I), of whom 51 attended the clinic and five distant patients responded by telephone. Interviews were conducted between 6 months and 5 years (mean 26 months) after operation. At the end of the interview, facial nerve function was assessed independently in 51 patients by each of the investigators, according to the House and Brackmann grading system *(8)*.

The clinical case notes were subsequently reviewed for operative and early postoperative complications or morbidity. Pure tone audiometry was performed preoperatively and at routine follow-up. Tumour size was estimated in the majority of cases by Gadolinium-enhanced magnetic resonance imaging, and by contrast-enhanced computed tomography in the remainder. Tumour size ranged from 1 cm to 5 cm and none were entirely intracanalicular. For the purpose of analysis, the patients have been divided into two groups; those with tumours whose maximum diameter did not exceed 2.5 cm (51.7%) and those whose did (48.3%). Statistical analysis (Student's t test) did not reveal any relationship between age and tumour size ($t = 1.14$, $P = 0.26$).

Results

Presenting symptoms

The frequency of initial symptoms is shown in Table II. Unilateral hearing impairment was the most common presenting symptom and affected 41 patients, nine of whom experienced sudden hearing loss. In decreasing frequency, the remainder reported symptoms of balance problems, tinnitus and sensory disturbance of the tongue or the face. Interestingly, three patients presented with the complaint of a fullness in the ear or head and were convinced that they were harbouring space-occupying lesions. Sixteen patients (28.6%) complained of the simultaneous onset of two or more symptoms. The time between onset of symptoms and final diagnosis varied from 3 months to 14 years. In 37.5% of the patients the time to diagnosis exceeded 4 years; while 25% were diagnosed within 1 year, another 25% between 1 and 2 years and the remaining 12.5% from 2 to 4 years.

Table I. Patients' details

Size group	*No. of operations*	*Sex*		*Age mean*	*Range*
		M	*F*		
<2.5 cm	30 (51.7%)	14	15	52.3	32–76
>2.5 cm	28 (48.3%)	8	19	59.4	22–79
Total	58	22 (39.2%)	34 (60.8%)	55.6	22–79

Table II. Presenting symptoms

Symptom	*Number*	*Percent*
Unilateral hearing impairment	41	73.2
Balance problems	10	17.9
Tinnitus	8	14.3
Symptoms affecting the face (numbness, pain) or tongue	6	10.7
Sensation of fullness in the ear or head	3	5.4
Others (eg headaches, swallowing difficulty)	4	7.1

Hearing difficulties

By the time of surgery, 48 patients (85.7%) experienced unilateral sensorineural hearing impairment, 6 (10.7%) had bilateral loss, and only two patients (3.6%) had undisturbed hearing. The patients' subjective estimation of their hearing loss, before and after operation, is shown in Fig. 1. Postoperative audiometry revealed that 10 patients had some residual hearing in the operated ear, but only five of them (8.9%) considered this useful. Only one had hearing slightly improved by surgery. Statistical analysis of hearing thresholds in the affected ear immediately before operation and tumour size (<2.5 cm or >2.5 cm), did not reveal a significant difference between the two groups ($t=1.24$, $P=0.22$).

One patient had used a hearing aid before surgery on the ear ipsilateral to the tumour, while seven had used an aid on the contralateral ear, and a further three patients were provided with hearing aids for their contralateral ears within 1 year after operation. Of these 11 patients, eight were still using their hearing aid at follow-up; half of them found the aid of use on a daily basis and the other half only occasionally (eg for watching TV, meetings). Two of these hearing aids were monocross. The two patients with bilateral tumours and deafness are awaiting cochlear implant insertion.

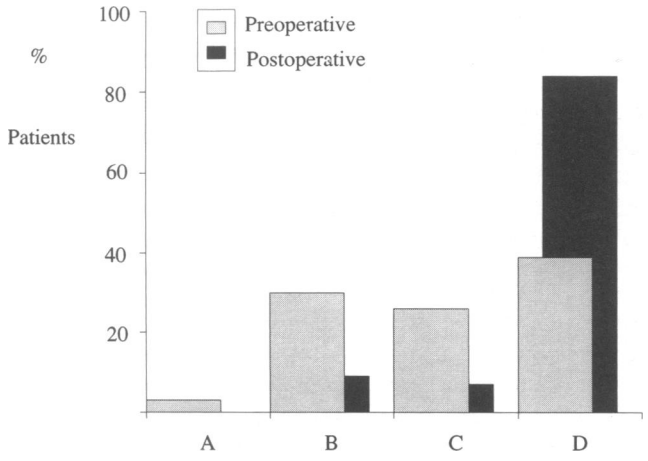

Figure 1. Subjective assessment of hearing loss. A, No loss of hearing; B, Difficulty on telephone; C, Difficulty in conversation; D, Useless ear.

Facial weakness

By the time of surgery, eight patients (14.3%) had experienced some degree of facial nerve dysfunction, one of whom presented acutely with a dense palsy (House–Brackmann grade V) due to haemorrhage within the tumour. Immediately after operation, 31 patients (55.4%) experienced some degree of facial weakness; 5 (8.9%) required tarsorrhaphy, 1 (1.8%) had a facial–hypoglossal nerve anastomosis and 1 (1.8%) had a fascial sling to the angle of the mouth.

At follow-up, 11 patients (19.7%) had a noticeable facial weakness (House–Brackmann grade III or worse), while 45 (80.3%) had normal or near normal facial movements (House–Brackmann grade I/II). There was no significant correlation between tumour size or preoperative facial weakness and eventual function. On three occasions the examiners disagreed on the House–Brackmann grading, all when mild facial asymmetry was interpreted as normal by one observer and mild impairment by the other. In three other cases, the examiners agreed that there were elements of two grades (III and IV) within an individual. The patients were asked to give a subjective estimation of their own facial nerve function, expressed as a percentage, and this was compared with the assessment of the examiners. There was a close correlation (Pearson's Product $r=0.98$, $P<0.001$) when patients had normal or near normal function (grade I/II), but a poor correlation ($r=0.38$, $P>0.05$) when the patients had noticeable weakness (grade III or worse). The latter patients tended to be more pessimistic than the examiners, which was perhaps indicative of the profound impact that this disability has had on their body image.

Balance problems

Dysequilibrium was the initial symptom in 10 patients, which was characteristically episodic, but with a progressive tendency towards longer periods of imbalance. By the time of operation, 39 patients (69.6%) were aware of balance problems. These were described as instability (79.4%), vertigo (12.8%) or mixed (7.8%). All those experiencing vertigo alone were in the small tumour size group. At the time of interview, 32 patients (57.1%) had some problem with balance; 7 (12.5%) of whom had developed them after operation. In 14 patients the symptoms were resolved by surgery, representing just over one-third of those with dysequilibrium preoperatively (Table III). Figure 2 shows the presence of imbalance, before and after surgery, in each tumour size group. The preoperative incidence was greater in patients with larger tumours, but they seemed to receive more benefit from surgery than the group with smaller tumours. Overall, the occurrence, duration and severity of imbalance was slightly reduced by tumour excision, but was sufficiently disturbing in 12.5% to impair the resumption of a normal lifestyle (Fig. 3).

Table III. Incidence of long-term symptoms after surgery

Symptom / *Size*	*Symptom abolished after surgery*			*Symptom developed after surgery*		
	< 2.5 cm	*> 2.5 cm*	*Total*	*< 2.5 cm*	*> 2.5 cm*	*Total*
Imbalance	27.8%	42.9%	35.9%	20.7%	3.7%	12.5%
Tinnitus	29.4%	21.4%	25.8%	20.7%	20.7%	20.7%
Headaches	21.7%	72.7%	47.4%	67.3%	21.7%	41.2%
Mood disturbance	0.0%	3.6%	1.8%	5.4%	7.1%	6.3%
Taste/tear disorder	1.8%	0.0%	0.6%	14.3%	17.8%	16.1%
Speech/swallowing	0.0%	0.0%	0.0%	8.9%	8.9%	8.9%
Monoparesis	0.0%	0.0%	0.0%	0.0%	3.6%	1.8%

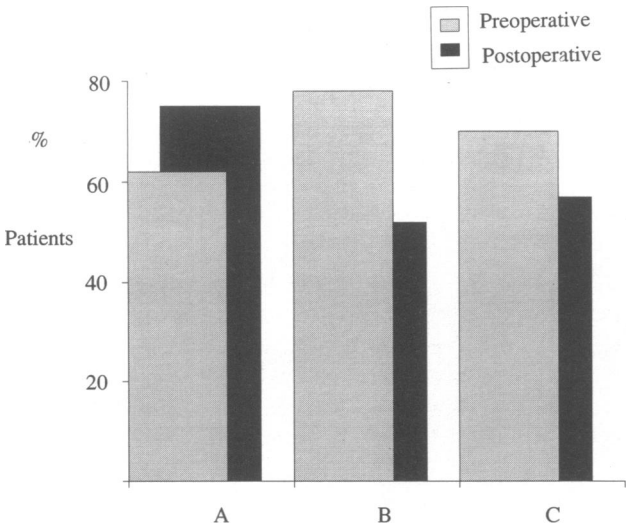

Figure 2. Incidence of balance problems before and after operation. A, Tumour < 2.5 cm; B, Tumour > 2.5 cm; C, All tumours.

Tinnitus

Tinnitus was the initial symptom in eight patients, but 31 (55.4%) had developed it by the time of surgery. More than half reported a continuous sensation of noise (buzzing, hissing, ringing or fluttering), which was aggravated by physical exertion, emotional stress or loud environmental sounds. Tumour size had little bearing on the occurrence of tinnitus (Fig. 4). After operation, six patients experienced tinnitus for the first time, while eight no longer suffered with it; leaving 29 (51.8%) complaining of it at the interview. Of these latter patients, about one-fifth reported that their symptoms were mildly alleviated by surgery (Fig. 5). Overall, however, a majority thought their tinnitus was unchanged or made worse by surgery (Fig. 6), although this was rarely disabling.

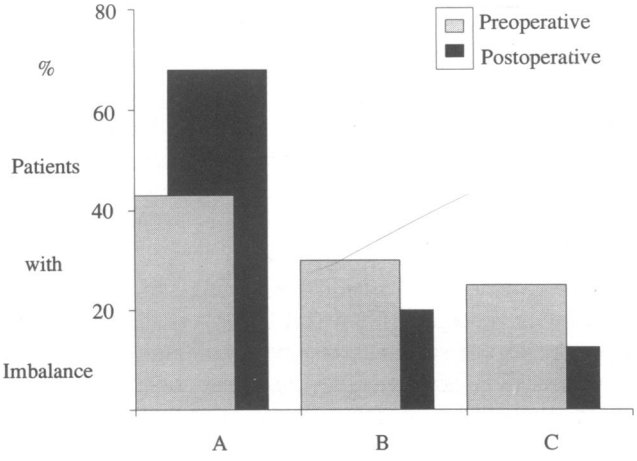

Figure 3. Subjective assessment of distress due to imbalance before and after operation. A, Little distress; B, Moderate distress; C, Severe disruption of normal lifestyle.

Headaches

At some point in their illness 26 patients (46.4%) experienced unfamiliar headaches, which were characteristically dull in nature and occurred on a daily basis. The pain was most frequently located occipitally, followed by frontal and temporal sites; with as many patients experiencing pain bilaterally as unilaterally. Before surgery, 19 patients (33.9%) complained of headaches; nine of whom experienced resolution of these postoperatively. After operation, seven patients experienced headaches for the first time, leaving 17 (30.4%) with this symptom at the time of interview. Patients with larger tumours were more likely to experience headache preoperatively, but also reported greater relief from tumour excision (Fig. 7). However, once again, surgery brought little overall change in the distress caused by this symptom (Fig. 8). Indeed, 16 patients (28.6%) reported such severity of pain as to interfere with normal daily activities on an intermittent basis. More recently, replacement of the craniotomy bone flap has reduced the occurrence of postoperative headache.

Other symptoms

Before surgery, four patients experienced some anxiety or depression, three had nervus intermedius dysfunction (disturbance of lacrimation or gustation), three had disorders of their lower cranial nerves (difficulty in articulation or swallowing) and two had long tract signs (monoparesis). At interview, 11 patients (19.6%) reported that they had experienced significant anxiety or depression after surgery; 3 (5.4%) of whom required antidepressants and/or inpatient psychiatric care. After

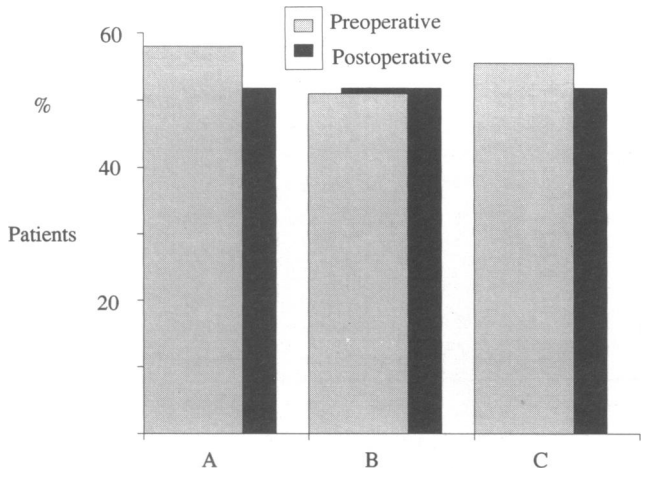

Figure 4. Incidence of tinnitus before and after operation. A, Tumour <2.5 cm; B, Tumour >2.5 cm; C, All tumours.

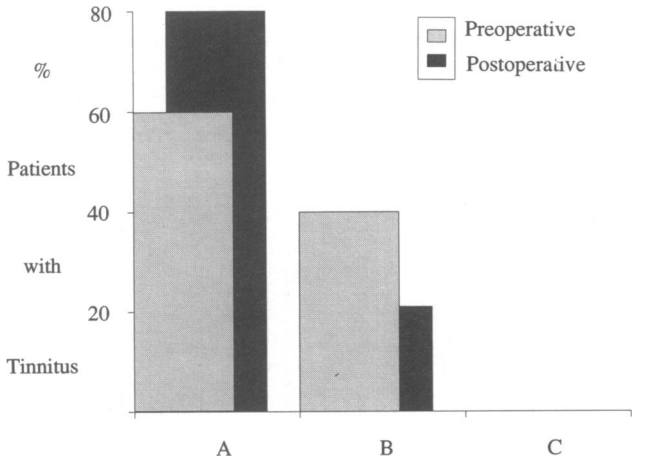

Figure 5. Subjective assessment of distress due to tinnitus before and after operation. A, Little distress; B, Moderate distress; C, Severe disruption of normal lifestyle.

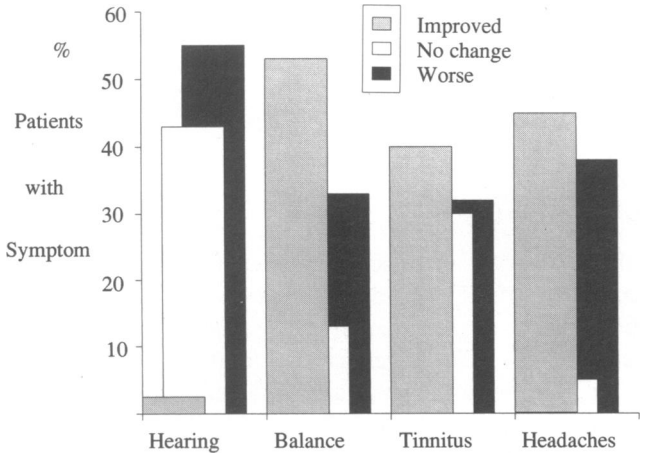

Figure 6. Subjective estimation of the alteration in symptoms after operation.

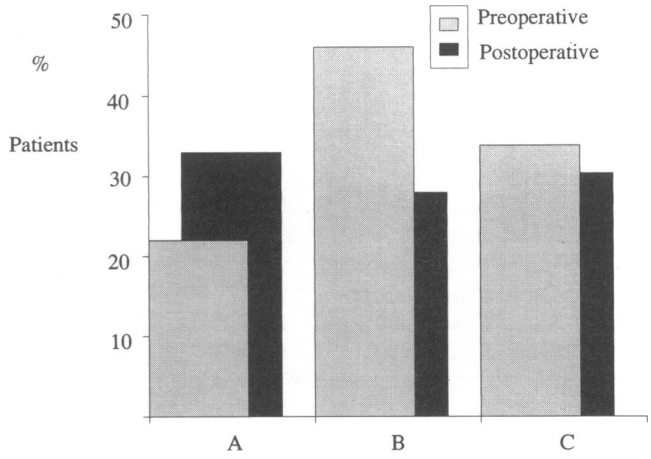

Figure 7. Incidence of headaches before and after operation. A, Tumour <2.5 cm; B, Tumour >2.5 cm; C, All tumours.

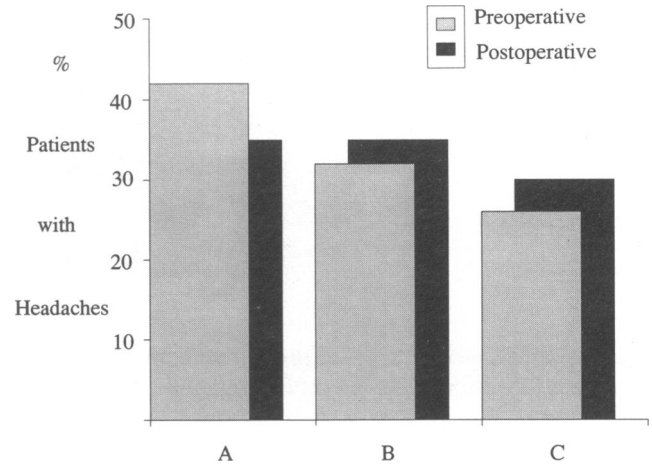

Figure 8. Subjective assessment of distress due to headaches before and after operation. A, Little distress; B, Moderate distress; C, Severe disruption of normal lifestyle.

surgery, 21 patients (37.5%) had alteration of lacrimation or taste, albeit transient in six; 13 (23.2%) had problems articulating or swallowing, and 4 (7.1%) had mild weakness in one limb.

Return to activity after operation

The complications of surgery included one perioperative death, one cerebellar hemisphere infarction, one posterior fossa haemorrhage, three cases of meningitis (two aseptic) and nine cerebrospinal fluid (CSF) leaks, of which three required surgical repair and four necessitated ventriculo-peritoneal (VP) shunts. Having recovered from their complication the eventual outcome of these patients was not significantly worse than those making uncomplicated recoveries.

In terms of regaining their general preoperative condition, 23 patients (41.0%) estimated that it took less than 4 months, 14 (25.0%) between 4 and 12 months,

while 19 (33.9%) did not feel they had regained their former health. Of these, five patients (8.9%) considered that surgery had produced an unacceptable change in their physical well-being. Despite these findings, some 80% of patients had returned to their previous social activities by the time of interview. The principal causes of failure to resume pastimes were: hearing impairment (creating difficulty during group discussions), balance problems (impairing physical activity) and facial weakness (producing embarrassment).

Of the 35 patients who had been working before surgery, 25 (71.4%) had returned to their previous employment, 5 (14.3%) had taken voluntary redundancy, 3 (8.6%) were certified unfit for work and 2 (5.7%) had vocational change or retraining. Of those who returned to work after their operation, two-thirds did so within 4 months and one-third by 12 months.

Discussion

The aim of surgery for acoustic neuroma is to prevent death from brainstem compression and eradicate the disease where possible. It is intended that patients will experience minimal functional impairment and be able to resume their former activities. In trying to optimise the neurological outcome of acoustic neuroma surgery many authors have stressed the importance of early diagnosis *(9–11)*. The onset of unexplained unilateral sensorineural deafness warrants investigation, particularly if accompanied by any complaint of progressive imbalance, vertigo or headache. Involvement of an adjacent cranial nerve should heighten suspicion, in particular vestibular dysfunction which is characteristic of small intracanalicular tumours, as borne out by this and other studies *(12,13)*. While some neurological deficits may be prevented by early intervention in smaller tumours, it is clear from our limited series that the symptomatology is not radically improved by surgery, whatever the tumour size. In view of the fact that radiosurgery can arrest tumour growth in 90% or more of cases under 3.0 cm diameter *(14)*, we await a similar audit of symptoms for this treatment. Better results would be a strong indication for preferring radiosurgery in smaller tumours, provided that satisfactory evidence of tumour control can be demonstrated over an adequate follow-up period. However, at present microsurgery in experienced hands remains superior to radiosurgery in preserving useful hearing, particularly in bilateral acoustic neuroma cases *(15,16)*.

The objective surgical results in these patients are satisfactory, with good functional preservation rates of 80% for the facial nerve (House–Brackmann grade I/II), and useful hearing in 27.3% of those with a previously functioning acoustic nerve *(1)*. These results are better than other recent British series *(9,10)*, but not as good as those reported by some superspecialist departments *(13,15)*. Our current findings reveal that a significant proportion of patients (33.9%) have residual symptoms (dysequilibrium, headache, mood disturbance, taste alteration). The prevalence of pre- and postoperative symptoms found in this study are similar to those of some previous patient surveys *(3,4)*. We were surprised that 19.6% of our patients had biological features of depression postoperatively, although figures of 17% *(4)* and 28.9% *(5)* have previously been reported. We do not know if this is a disease-related or a non-specific phenomenon, although it is comparable to the 15% found postoperatively in patients treated surgically for benign trigeminal neuralgia *(17)*. Our findings support the suggestion by Hardy and Moffat that there may be disparity between the surgeons' and the patients' perspectives of outcome *(2)*. The majority of symptoms are absent at the time of first presentation and are not alleviated later by tumour excision. If therapeutic intervention were to prevent the onset of such symptoms, it may provide an additional incentive for early diagnosis and treatment of acoustic neuroma. Indeed early surgery has already been advocated for the preservation of hearing *(18)*. Ironically, however, the general level of satisfaction reported postoperatively by our patients is relatively greater in patients who had larger tumours.

Despite the serious nature of this disease and its sequelae, it was gratifying to find that so many of our patients had resumed their former social and vocational activities. In spite of the severity of their symptoms, only 8.6% of our patients were certified medically unfit for work, and of those working preoperatively over 70% had returned to their jobs. These figures are in accord with the postal surveys of Wiegand and Fickel *(3)* and Parving *et al. (4)*, in which 7% and 13% of respondents were unable to perform vocational activities, respectively. Two smaller studies reported unemployment rates of 33% *(6)* and 38% *(5)*. Some 20% of our patients reported residual disabilities which impeded their normal social activities and pastimes. Deafness, imbalance and reduced facial nerve function account for the majority of these restricting impairments. While microsurgeons strive to improve results over future years, we recommend realistic and adequate counselling to help patients cope with the lower grade sequelae of acoustic neuroma treatment.

References

1 Torrens MJ, Maw AR, Coakham HB *et al.* Facial and acoustic nerve preservation during excision of extracanalicular acoustic neuromas using the suboccipital approach. *Br J Neurosurg* (in press).

2 Hardy DG, Moffat DA. Acoustic neuroma surgery: how much morbidity is swept under the carpet. 3rd European Congress of Surgery. London, 17 September 1993.

3 Wiegand DA, Fickel V. Acoustic neuroma—the patient's perspective: subjective assessment of symptoms, diagnosis, therapy, and outcome in 541 patients. *Laryngoscope* 1989; **99**: 179–87.

4 Parving, A, Tos M, Thomsen J, Moller H, Buchwald C. Some aspects of life quality after surgery for acoustic neuroma. *Arch Otolaryngol* 1992; **118**: 1061–4.

5 Jorgensen B, Pedersen CB. Medical and socio-economic

status of patients operated on for acoustic neuroma. In: Tos M, Thomsen J, eds. *Acoustic Neuroma*. Amsterdam/New York: Kugler Publications, 1992: 881–6.

6 Mercke U, Magnusson M, Linderoth L, Harris S, Sundbarg G. Long-term effect of translabyrinthine acoustic neuroma surgery on work capacity. In: Tos M, Thomsen J, eds. *Acoustic Neuroma*. Amsterdam/New York: Kugler Publications, 1992: 877–80.

7 Fletcher A, Gore S, Jones D, Fitzpatrick R, Spiegelhalter D, Cox D. Quality of life measures in health care. II: Design, analysis, and interpretation. *Br Med J* 1992; **305**: 1145–8.

8 House JW, Brackmann DE. Facial nerve grading system. *Otolaryngol Head Neck Surg* 1985; **33**: 146–7.

9 Lee TKY, Lund WS, Adams CBT. Factors influencing the preservation of the acoustic nerve during acoustic surgery. *Br J Neurosurg* 1990; **4**: 5–8.

10 Hardy DG, Macfarlane R, Baguley DM, Moffat DA. Facial nerve recovery following acoustic neuroma surgery. *Br J Neurosurg* 1989; **3**: 675–80.

11 Chandler CL, Ramsden RT. Acoustic schwannoma. *Br J Hosp Med* 1993; **49**: 335–43.

12 Selesnick SH, Jackler RK, Pitts LW. The changing clinical presentation of acoustic tumours in the MRI era. *Laryngoscope* 1993: **103**: 431–6.

13 Samii M, Tatagiba M, Matthies C. Acoustic neuroma in the elderly: factors predictive of postoperative outcome. *Neurosurgery* 1992; **31**: 615–19.

14 Jones KD, Eldridge R, Parry D. Summary: vestibular schwannoma (acoustic neuroma) concensus development conference. *Neurosurgery* 1993; **32**: 878–9.

15 Nadol JB, Chiong CM, Ojemann RG *et al.* Preservation of hearing and facial nerve function in resection of acoustic neuroma. *Laryngoscope* 1992; **102**: 1153–8.

16 Moskowitz N, Long DM. Historical review of a century of operative series. *Neurosurg Q* 1991; **1**: 2–18.

17 Zakrzewska JM, Thomas DG. Patient's assessment of outcome after three surgical procedures for the management of trigeminal neuralgia. *Acta Neurochir (Wien)*, 1993; **122**: 225–30.

18 Haines SJ, Levine SC. Intracanalicular acoustic neuroma: early surgery for preservation of hearing. *J Neurosurg* 1993; **79**: 515–20.

Received 2 September 1994