ported in association with ICA dissection. Severe forms of trauma associated with ICA dissection include various types of blunt and penetrating injury, strangling, hanging, seat belt injuries, and whiplash.[2] Several other relatively trivial forms of trauma have also been reported to precede dissection and these include vomiting, coughing, nose blowing, eating, brushing teeth, shaving, playing tennis, skiing, diving, scuba diving, and chiropractic adjustments.[1,5] A detailed history may reveal the cause of an otherwise presumed spontaneous ICA dissection.

This report of two cases of ICA dissection that appear to be associated with the use of shiatsu massagers potentially represents a newly described traumatic etiology. In Patient 1, the duration of the contact with the shiatsu massager followed by the immediate development of symptoms provide relatively strong evidence suggestive of causality. With Patient 2, there was a more significant delay between the use of the massager, and the subsequent development of symptoms and causality is not as clear. However, there was no other significant history of potential trauma for this patient, and a delay between a given trauma and the subsequent development of dissection has been reported by others.[2] Whether certain individuals are genetically more vulnerable to the effects of minor trauma and thereby prone to cervical artery dissections has yet to be definitively established. This will require further studies to elucidate. This report establishes that the use of shiatsu-type massagers should be considered along with other forms of trauma when evaluating patients with idiopathic ICA dissection.

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Handheld cellular telephones and risk of acoustic neuroma

Abstract—The hypothesis that intracranial energy deposition from handheld cellular telephones causes acoustic neuroma was tested in an epidemiologic study of 90 patients and 86 control subjects. The relative risk was 0.9 (p = 0.07) and did not vary significantly by the frequency, duration, and lifetime hours of use. In patients who used cellular telephones, the tumor occurred more often on the contralateral than ipsilateral side of the head. Further efforts should focus on potentially longer induction periods.

NEUROLOGY 2002;58:1304–1306

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Acoustic neuromas, or acoustic neurilemoma or Schwannomas, arise from the Schwann cells of the nerve sheath surrounding the vestibulocochlear (VIII) cranial nerve. There are no established environmental causes of acoustic neuroma, although there have been suggestions that handheld cellular telephones are risk factors. In the United States, there are more than 118 million cellular telephones subscribers (go to www.wow-com.com/industry/stats/articles.cfm?ID=250 for more information). The radiofrequency radiation emitted from cellular telephones during transmission is absorbed superficially on the skin and bones surrounding the ear, and intracranially behind the ear.[1] Radiofrequency radiation does not possess sufficient energy to remove electrons from molecules, and causes little increase in the temperature of facial or brain tissue. Despite the lack of a known carcinogenic effect of radiofrequency radiation from cellular telephones, there are public health concerns about their safety. The relative risk of acoustic neuroma associated with use of handheld cellular phones was estimated as 0.9 (p = 0.63) in a recent hospital-based, case-control study.[2] In a Danish cohort of cellular phone users followed for 13 years, the observed number of (all) cranial nerve tumors was 7, whereas the expected number was 11.[3] This investigation examined the

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Presented at the Congress of Epidemiology; Toronto, Canada; June 13–16, 2001.

Supported by a contract from Wireless Technology, Inc. and Public Health Service grants NCI 32617, 68384, and 17613.

Received August 3, 2001. Accepted in final form January 12, 2002.

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Table 1 *Characteristics of acoustic neuroma patients and control subjects*

Characteristic	Patients (%)	Cell phones (%)	Control subjects (%)	Cell phones (%)
All Subjects	90	20.0	86	26.7
Sex				
Male	47 (52.3)	29.8	44 (51.2)	31.8
Female	43 (47.8)	9.4	42 (48.8)	21.4
Age, y				
<40	11 (12.2)	27.3	10 (11.5)	40.0
41–50	25 (27.8)	20.0	28 (32.6)	25.0
51–60	26 (28.9)	30.8	23 (26.7)	39.1
>60	28 (31.1)	3.6	25 (29.1)	3.5
Education, y				
<12	4 (4.4)	25.0	6 (7.0)	33.3
12	14 (15.6)	7.1	15 (17.4)	20.0
13–15	18 (20.0)	16.7	12 (14.0)	33.3
16	19 (21.1)	5.3	21 (24.4)	28.6
>16	35 (38.9)	34.3	32 (37.2)	25.0
Occupation				
Professional	39 (43.3)	33.3	34 (39.5)	32.4
Managerial	13 (14.4)	23.1	16 (18.6)	18.8
Sales	5 (5.6)	20.0	11 (12.8)	72.7
Clerical	18 (20.0)	5.6	13 (15.1)	0.0
Other	15 (17.6)	0.0	12 (14.0)	16.6

Table 2 *OR for acoustic neuroma by handheld cell phone use*

Cell phone use	Patients, n = 90 (%)	Control subjects, n = 86 (%)	OR* (95% CI)	Trend test *p* value
Years				
0	72 (80.0)	63 (73.3)	1.0	
1–2	7 (7.8)	17 (19.8)	0.5 (0.2, 1.3)	
3–6	11 (12.2)	6 (7.0)	1.7 (0.5, 5.1)	0.84
Hours/month				
0	72 (80.0)	63 (73.3)	1.0	
1–2.5	11 (12.2)	11 (12.8)	1.1 (0.4, 2.9)	
>2.5	7 (7.8)	12 (14.0)	0.6 (0.2, 1.7)	0.40
Total hours				
0	72 (86.7)	63 (73.3)	1.0	
1–60	9 (10.0)	11 (12.8)	0.9 (0.3, 3.1)	
>60	9 (10.0)	12 (14.0)	0.7 (0.2, 2.6)	0.53

	Tumor laterality			
Cell phone handedness	Left	Right	Relative Risk	
Left	4	7	0.9	0.07†
Right	6	1		

* Adjusted for age, years of education, sex, study center, occupation categories, and month and year of interview.

† Based on Fisher exact test.

association of handheld cellular telephone risk in 90 patients with acoustic neuroma.

Methods. New York University Medical Center and New York Presbyterian Medical Center conducted a case-control study of acoustic neuroma from 1997 to 1999 as part of a larger study on brain tumors.[4] Patients were 18 years of age or older with histologically-confirmed acoustic neuroma (90 patients diagnosed with International Classification of Diseases (ICD) 225.1, 3 patients with ICD 192). Eighty-six in-patients with a wide variety of nonmalignant conditions (e.g., predominately musculoskeletal disorders, digestive disorders, diseases of circulatory system, disc and spinal disorder, fractures, osteoarthrosis) were selected as controls from admission lists and were frequency matched to patients by age (within 5 years), sex, race, and hospital. All eligible patients were approached after surgery, and both patients and control subjects were asked to sign an approved consent form that described the general goals of the study (e.g., risk factors for brain tumors). Interviews were performed in person except for one patient whose replies were provided by the spouse. The structured questionnaire contained detailed questions on handheld cellular telephone use and lifestyle information such as smoking habits, alcohol consumption, medical history, occupations, and occupational exposures. Subjects were asked if they ever used a handheld cell phone "on a regular basis," that is, having had a subscription to a cellular phone service. Information was obtained on the number of years of use, minutes/hours used per month, year of first use, manufacturer, and reported average monthly bill. If the subscriber was anyone other than the subject, the percent of time that the subject used the cellular telephone was used to estimate the proportion of the bill due to the subject's use. Data on which hand was used to hold the cell phone were collected from all subjects. Collaboration was sought with oncologists, neurosurgeons, nurses, and other staff. Interviewers consulted with the hospital staff to determine the most appropriate time to approach patients. The histologic type and anatomic location of the tumor were obtained from the pathology and MRI reports.

Statistical analysis. The Spearman correlation coefficient was calculated to measure the relationship between the monthly hours of handheld cell phone use and the reported monthly bill. Multivariate unconditional logistic regression models were used to derive OR and 95% CI associated with handheld cellular phone use relative to nonusers. The models were based on the frequency, duration, and cumulative use of cellular telephones, and adjusted for age, years of education, sex, study center, occupational categories, and date of interview. Tests for trend were calculated by assigning the midpoint value of each exposure category. The OR is considered an estimate of the relative risk, a measure of the ratio of the incidence of disease in a population of exposed to unexposed individuals. Because a more valid "exposure" measurement for cellular telephones use might be limited to use on the ipsilateral cranial area of the tumor, the relative risk for acoustic neuroma associated with handheld cellular telephones was estimated from the OR using an approach accounting for the laterality of the tumor (right, left) and the users' cellular phone handedness (right, left). The formula for this relative risk is estimated as $(\sqrt{OR} + 1)/2$ and

its derivation is described elsewhere.[5] It can be interpreted as a handedness-adjusted measure of the association between cellular telephone use and acoustic neuroma. All analyses were performed using SAS software (Cary, NC) and all p values were two-sided.

Results. The age, levels of education, race, and occupation of the study subjects are shown in table 1. The mean age was 54 years in both patients and control subjects, and the mean education was 15 years in patients and control subjects. There were little differences in race and occupation.

Eighteen patients (20.0%) and 23 control subjects (26.7%) reported regularly using handheld cellular telephones. Patients used the telephones on average for 4.6 hours per month and 4.1 years, compared with 6.6 hours per month and 2.2 years for control subjects. There was a moderate correlation between monthly use and the estimated monthly phone bill ($r = 0.44$). The risk for acoustic neuroma was unrelated to the frequency and duration of cellular telephones, although an elevated risk was found for subjects with 3 or more years of use (OR = 1.7, 95% CI 0.5 to 5.1; table 2). However, these subjects were also infrequent users and no association was observed with cumulative use (see table 2). There was no evidence of a trend in the OR with increasing levels of exposure. None of the overall tests for the multivariate logistic regression models was significant, except for one polynomial model that included terms for years of exposure and its square, and no covariates ($p = 0.04$).

Four of 11 left-handed patients and 1 of 7 right-handed patients who used cellular telephones had ipsilateral tumors (relative risk for acoustic neuroma; 0.9, $p = 0.07$; see table 2).

Discussion. The study did not support the hypothesis that use of handheld cellular telephones causes acoustic neuroma. No association was observed with cumulative use of cellular phones, and the tumor was located more frequently on the contralateral than ipsilateral side of the head. These findings are consistent with two other studies.[2,3]

The current study was conducted about a decade after the introduction of cellular telephone technology, and did not measure the risks associated with long-term cellular telephone use, or with frequent daily use that is more typical of contemporary patterns. Further studies are needed to explain the relation of greater lifelong exposure to handheld cellular telephones and tumor risk. An apparent increased risk was found for the subjects that used cellular phones for more than 3 years, which provides some basis for examining longer exposure periods. In this study, at least, the long-term users were also infrequent users and hence no relationship was observed with cumulative lifelong exposure.

A limitation of these types of studies is the lack of information on time between symptomology and diagnosis, and between diagnosis and treatment. In a review of 164 consecutive patients undergoing surgery for acoustic neuroma between 1980 and 1992, the mean patient delay between first symptoms and the visit to the general practitioner was 35.7 months,[6] and 15.2 months between the visit to the specialist and the radiologic diagnosis. However, the increased accessibility and routine use of MRI scanning in recent years has reduced the time to make a definitive diagnosis. Another study limitation is the inability to account for the time between the formation of the tumor and symptomology. In a review of 24,246 MRI head scans conducted for reasons other than suspicion of acoustic neuroma, 17 patients (0.07%) were observed to have unsuspected acoustic neuroma.[7] Hearing loss associated with acoustic neuroma might also have influenced the current findings. Patients were more likely to have used the cellular phone on the contralateral ear. It is possible that this finding reflects a hearing loss in the affected ear, although no information was collected on whether symptomology resulted in some patients switching their hand preference. It was also not possible to validate self-reported cellular telephones use because billing records were not obtained. However in a separate study of more than 5,000 subscribers, there was a high correlation ($r = 0.74$) between reported cellular telephone use and company billing records.[8] Further collaborative efforts between industry and government to study the effects of RF on brain tumors are ongoing (go to www.fda.gov/cdrh/ocd/wlessphonecrada.html for more informaiton).

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