Scala Tympani Cochleostomy I: Results of a Survey

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Objective: To assess current surgical techniques for scala tympani cochlear implantation among North American surgeons.

Material: A survey was distributed to all cochlear implant surgeons participating in the 2006 William House Cochlear Implant Study Group in Toronto, Canada. Participants were asked to anonymously identify their routine surgical practices. Images of trans-facial recess approaches to the round window and cochlear promontory were used in a multiple-choice fashion to assess the surgeon's typical exposure and cochleostomy location. Returned questionnaires were electronically processed and evaluated.

Results: Fifty-five (75%) of 73 returned surveys had adequate data validity and availability. Landmark identification and preferred cochleostomy locations varied greatly. About 20% of surgeons selected cochleostomy locations superior to the round window membrane. Cochleostomy size and location appeared to be influenced by surgical experience and whether or not the round window overhang was drilled off.

Conclusion: This survey clearly documents marked variations in surgical techniques for scala tympani cochlear implantation. Future studies should more clearly define the surgical anatomy of this region for appropriate placement of a scala tympani cochleostomy. These findings may ultimately have an impact on hearing and neural preservation cochlear implant surgeries.

Key Words: Survey, cochlear implant, surgery, cochleostomy, scala tympani.

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INTRODUCTION

For uncomplicated cochlear implantation, a number of factors make scala tympani (ST) the ideal location for most electrode arrays. First ST has a slightly larger diameter than scala vestibuli (SV) and can thus better accom-

modate the electrode array.¹ This location allows for electrode insertion below the fragile cochlear duct and in close proximity to the spiral ganglion cell bodies. Importantly, SV and scala media (SM) are separated only by Reissner's membrane, a fragile two-cell layered structure. Thus, electrode insertions into SV generally result in greater intracochlear trauma.² Another reason for using ST instead of SV is the relatively convenient relationship of ST to the round window membrane.

William F. House was among the first to use the trans-facial recess route for permanent cochlear implantation into the scala tympani via the round window membrane in the early 1970s.³ For the single-channel device, the round window provided an adequate angle for electrode insertion into the first few millimeters of the basal segment of the cochlea.⁴ Subsequently, deeper insertions of multi-electrode arrays became the target in an effort to access the tonotopical arrangement of the cochlea.⁵ Unfortunately, these early electrode arrays generated relatively high resistive forces to insertion. Using the round window membrane, the angle of insertion frequently resulted in electrode buckling and associated trauma. Thus, a separate cochleostomy site was advocated in an effort to use a straighter, in-line, electrode insertion.⁶ The straight insertion afforded via the separate cochleostomy accomplished the desired greater insertion depths while minimizing both electrode and cochlear trauma.⁷

Few studies have described the surgical anatomy of the promontory region relevant to cochlear implantation.^{8,9} No studies have correlated topographical, surgical cochleostomy locations with associated intracochlear trauma. Moreover, the functional consequences of various cochleostomy openings are just beginning to be explored. In a recent study, scala tympani electrode placement was found to be significantly associated with improved speech perception results.¹⁰ With the recent advent of bimodal-electrical and acoustic stimulation within the same ear, hearing preservation in cochlear implantation has taken on even greater importance.^{11,12} While the etiology of implant-induced hearing loss remains speculative, most believe that precise location of the cochleostomy within the scala tympani is of paramount importance.^{9,13,14}

It is commonly held that to enter the scala tympani, an anterior and inferior cochleostomy is needed in relation to the round window membrane. In an excellent review by

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TABLE I.
Responses for Each Valid Questionnaire.

Questionnaire	1 Implants (n)	2 Drill†	3 Burr Size†	4 Facial Nerve	5 Chorda Tympani	6 Round Window	7 Size Opening	8 Drill Round Window	9 Round Window Insertions	10 Image 1	11 Exposure	11 Image 2	12 Image 3
1	50+	NA	1.0	Yes	No	Yes	0.8	No	Yes	9	Yes	6	9
2	50+	Skeeter	0.6	No	Yes	Yes	1.0	Yes	No	6	Yes	7	7
3	30-50	Midas rex	1.0	No	Yes	Yes	1.0	Yes	No	6	No		8
4	20-30	Medtronic	1.0	No	No	No	1.0	No	No	3	Yes	4	5
5	10-20	Skeeter	1.0	Yes	Yes	No	1.2	Yes	No	9	No	9*	8
6	30-50	Anspach	1.0	Yes	No	Yes	1.0	Yes	Yes	10	No	7*	10
7	0-10	Anspach	1.0	Yes	No	No	1.5	No	No	2	Yes	NA	4
8	0-10	Anspach	1.0	No	Yes	No	1.0	No	No	6	No		8
9	50+	Anspach	1.0	Yes	Yes	Yes	1.0	No	No	9	No		9
10	50+	Skeeter	0.6	Yes	No	No	0.8	Yes	No	9	No		9
11	10-20	Medtronic	1.0	Yes	Yes	Yes	1.0	No	No	9	No	7*	9
12	30-50	MedNext	1.2	No	Yes	Yes	1.2	Yes	No	9	No		9
13	20-30	Medtronic	1.0	Yes	Yes	No	1.0	No	No	13	Yes	8	9
14	0-10	Medtronic	1.0	Yes	Yes	Yes	2.0	Yes	No	1	NA	NA	1
15	10-20	Medtronic	1.0	No	Yes	No	1.2	No	No	3	No	2*	7
16	0-10	Medtronic	1.0	Yes	Yes	No	1.5	Yes	No	2	No		7
17	20-30	Anspach	1.0	No	No	Yes	1.2	Yes	No	6	No		7
18	20-30	Anspach	1.0	Yes	Yes	Yes	1.2	Yes	No	6	No		7
19	20-30	Anspach	1.0	Yes	Yes	No	1.2	Yes	No	9	No	4*	9
20	30-50	Stryker	1.0	No	Yes	Yes	1.5	Yes	No	9	Yes	5	9
21	20-30	Linvatec	1.0	Yes	Yes	No	1.2	Yes	No	2	No		5
22	20-30	Skeeter	1.2	Yes	No	No	2.0	Yes	No	6	No		9
23	50+	NA	0.6	Yes	Yes	No	1.0	No	No	14	No		8
24	20-30	Anspach	1.5	No	No	Yes	1.5	Yes	No	6	No		9
25	0-10	Anspach	1.0	Yes	Yes	Yes	1.0	No	No	10	Yes	8	9
26	50+	Anspach	1.0	Yes	Yes	Yes	2.0	Yes	Yes	3	Yes	4	1
27	50+	Anspach	1.0	Yes	Yes	No	1.2	No	No	13	No		8*
28	30-50	Anspach	1.0	No	No	No	1.2	No	No	6	No		5
29	30-50	MedNext	0.6	Yes	Yes	Yes	0.8	Yes	No	9	Yes	4	9
30	10-20	NA	1.0	Yes	Yes	Yes	2.0	No	No	10	No		10
31	20-30	Anspach	1.0	No	Yes	Yes	1.5	No	No	9	No		11
32	10-20	NA	1.0	Yes	No	No	1.2	No	No	7	No		8
33	0-10	Linvatec	1.0	Yes	Yes	No	1.0	No	No	2	Yes	8	7
34	20-30	Skeeter	1.0	Yes	Yes	Yes	1.2	No	Yes	3	Yes	7	1
35	10-20	Anspach	1.0	No	No	Yes	1.2	No	No	2	No		8
36	20-30	Anspach	1.0	No	No	No	1.0	Yes	Yes	6	No	8*	7
37	10-20	Medtronic	1.0	No	No	Yes	1.2	Yes	No	3	No		7
38	30-50	Anspach	1.0	Yes	Yes	No	1.5	No	No	13	Yes	8	7
39	10-20	Anspach	1.0	No	No	No	1.5	Yes	No	9	Yes	7	7
40	10-20	Stryker	0.8	Yes	No	Yes	2.0	Yes	Yes	5	No		7
41	10-20	Anspach	1.5	No	No	Yes	1.5	Yes	No	6	Yes	7	5
42	20-30	Anspach	1.0	Yes	No	Yes	1.0	No	No	10	No		9
43	0-10	Anspach	1.0	Yes	No	No	1.5	No	No	5	Yes	5	7
44	20-30	Anspach	1.0	Yes	Yes	No	1.0	Yes	Yes	3	Yes	4	6
45	10-20	Linvatec	1.0	No	Yes	No	1.2	No	No	7	No		9
46	20-30	Skeeter	1.0	Yes	Yes	Yes	1.5	Yes	No	9	No		9
47	50+	Anspach	1.0	Yes	Yes	Yes	1.0	Yes	Yes	11	Yes	7	10
48	50+	MedNext	1.0	Yes	Yes	No	1.0	No	No	2	Yes	7	7

(Continues)

TABLE I.
(Continued).

Questionnaire	1	2	3	4	5	6	7	8	9	10	11	11	12
	Implants (n)	Drill†	Burr Size†	Facial Nerve	Chorda Tympani	Round Window	Size Opening	Drill Round Window	Round Window Insertions	Image 1	Exposure	Image 2	Image 3
49	20–30	Gyrus	1.0	Yes	Yes	No	1.2	Yes	No	6	No		8
50	50+	Skeeter	1.0	Yes	Yes	Yes	1.2	Yes	No	7	Yes	7	9
51	50+	Medtronic	1.0	Yes	Yes	No	1.2	No	No	9	No		9
52	10–20	Anspach	1.0	Yes	Yes	Yes	1.5	Yes	Yes	6	No		8
53	10–20	Skeeter	1.5	No	Yes	No	2.0	No	No	6	No		7
54	10–20	Stryker	1.0	No	Yes	Yes	1.0	Yes	No	13	No		10
55	50+	Anspach	0.6	Yes	Yes	No	1.0	No	No	5	No		10

*Indicates surgeons who indicated that the facial recess exposure was adequate but who picked a cochleostomy location for the same image. These surgeons were excluded from data analysis for image 2 cochleostomy location.

†The smallest drill indicated by each surgeon was used for data analysis.

Briggs et al.,⁹ the authors noted that inferior drilling relative to the round window membrane should be more likely to ensure an atraumatic scala tympani insertion, although histologic insertion data were lacking. The fact that the spiral ligament attaches closely to the anterior and superior aspects of the round window membrane makes this area a high risk for cochleostomy-related trauma.

The aim of this article was to assess the current surgical practices of a group of North American cochlear implant surgeons with regard to exposure and cochleostomy location for scala tympani cochlear implantation.

MATERIALS AND METHODS

A survey (Appendix) containing 12 questions was distributed among surgeons participating at the William House Cochlear Implant Study Club in Toronto, Canada on September 16, 2006. A total number of 100 copies of the two-page survey were dispersed among participants, and a short announcement was made asking every surgeon to participate. The survey contained questions about the annual number of cochlear implant surgeries performed, the type and manufacturer of the drilling system used, questions about how each surgeon usually drills the facial recess and the cochleostomy, and three intraoperative images depicting various views through the facial recess onto the promontory. For orientation, all three photographs clearly contained the pyramidal process, stapedius tendon, round window niche and membrane. Two of the three photographs also contained the incudostapedial joint and fossa incudis.

All participants were asked to return the survey before leaving the meeting venue. Both authors checked the questionnaires for validity. Specifically, a single answer clearly marked had to be present for more than half of the questions. Ambiguous markings of the answer sheet were rejected. A copy of the questionnaire is shown in the Appendix. Raw data are displayed in Table I.

In the data review, some surgeons used annotations to indicate multiple responses or deviations from the multiple-choice items provided for each question. This was commonly observed for questions 2 and 7. For the latter question, some surgeons indicated variable cochleostomy diameters for different cochlear implant manufacturers. In those cases, the smallest burr or cochleostomy size was chosen for further data analysis. One questionnaire (1 of 73, 1.4%) was returned without specification of the annual number of implantations. Also,

five surgeons (6.8%) did not complete the second page of the two-page questionnaire.

Inconsistency was also observed within the surveys. Nine surgeons (12.3%) indicated that the promontory exposure shown in question 11 was inadequate but then selected a cochleostomy location in the corresponding image. Those nine answers were excluded from the evaluation of the cochleostomy site for image 2. One surgeon (1.4%) indicated that the facial recess exposure was adequate, but then failed to specify a cochleostomy location in the following image. Data validity was also checked using cochleostomy locations of images 1 and 3. For image 1 (question 10, left ear), locations 1, 2, and 3 were considered primarily *superior* to the round window membrane. Locations 4 through 7 were considered to be predominantly *anterior*, while locations 8 through 14 were considered *inferior* to the round window. Since the round window niche was unavailable for exact classification of cochleostomy location in surgical image 2 (question 11), locations 1 through 3 were estimated to be superior; 4 through 6 intermediate; and 7 through 9 inferior. Image 3 (question 12), on the other hand, shows a full exposure of the promontory, and locations 9, 10, and 11 were considered inferior; 7 and 8 anterior; and 8 through 12 superior to the round window niche.

Seven of the 73 surgeons (9.6%) had conflicting data, for example, selecting a superior cochleostomy location in one image and an inferior cochleostomy in the other one. It was presumed, in these cases, that right-left confusion between surgical images 1 and 3 existed.

The data were coded and entered in a computer-based spreadsheet (Microsoft Excel, Microsoft Corporation, Redmond, WA) and further statistical processing was performed using SPSS 11.0 (SPSS Inc., Chicago, IL). Significant relationships between variables were sought using Spearman's nonparametric correlation test. Statistically significant relationships were assumed for $P < .05$.

RESULTS

Surgeon Characteristics

A total number of 73 questionnaires were returned, whereas 18 had to be excluded from this evaluation due to data inconsistencies (either unavailable or conflicting data for images 1 and 3). Thus, 55 questionnaires showed proper data availability and consistency. Figure 1 graphically shows the tabulated responses for question 1 to 9. Of the 55 valid questionnaires, 61.8% of the surveyed

1: How many cochlear implants do you do per year?

2: What drill do you usually use for drilling the cochleostomy?

3: What size burr do you use for the cochleostomy?

4: Do you routinely identify the facial nerve in the facial recess?

5: Do you routinely identify the chorda tympani?

6: Do you routinely drill-off a part of the round window-niche overhang?

7: What size is your final cochleostomy?

8: Do you sometimes drill through a part of the round window membrane?

9: Do you sometimes perform round window insertions?

Fig. 1. Responses to questions 1 to 9 illustrated in pie graphs showing percentage distributions.

surgeons indicated that they perform more than 20 implants annually, making this a fairly experienced group.

Exposing the Cochlear Promontory

In terms of exposure, 34.5% of surgeons indicated that they do not routinely identify the facial nerve, and 32.7% do not identify the chorda tympani. Interestingly, 52.6% of surgeons that do not identify the facial nerve still identify the chorda tympani. Conversely, only 25.0% of surgeons who do identify the facial nerve do not usually identify the chorda tympani. In terms of round window-niche identification, question 11 showed an intraoperative, trans-facial recess exposure of the posterior mesotympanum that does not show the round window niche at all. Thirty-four percent of surgeons indicated that the exposure shown in this image was adequate for cochleostomy drilling and subsequently selected a location for placement.

Round Window Membrane Identification

After exposing the promontory, 50.9% indicated that they routinely drill off a portion of the round window bony overhang (question 6) and 60.7% of these individuals routinely identify the facial nerve within the facial recess, while 67.9% identify the chorda tympani.

Cochleostomy Location and Size

Sixteen percent of respondents sometimes perform round window electrode insertions, and 52.7% of surgeons indicated that they sometimes drill through a part of the round window membrane during cochleostomy. Of those that sometimes utilize the round window membrane for access, 77.8% drill off a portion of the niche prior to insertion, and 77.8% drill through a portion of the round window membrane on occasion.

About 83.6% of surgeons do not use the round window membrane for electrode insertion, thus preferring a separate cochleostomy. The vast majority of these

Fig. 2. Responses to questions 10, 11, and 12 of the survey illustrated via pie graphs showing the relative percentage values.

surgeons (78.3%) indicated that they use a 1.0-mm burr for drilling the cochleostomy. The remaining surgeons use a variety of burr sizes ranging from 0.6 mm to 1.5 mm. Most surgeons also indicated that they usually drill a 1.0-mm (32.7%) or a 1.2-mm (30.9%) cochleostomy, although 10.9% make a 2.0-mm cochleostomy opening. Forty-six percent of the surgeons who use a separate cochleostomy for electrode insertion also drill off a portion of the round window niche prior to insertion, while 47.8% drill through a portion of the round window membrane on occasion.

Detailed responses to the individual intraoperative images are illustrated in Figure 2. The bottom pie graphs summarize the selected cochleostomy locations.

Based on the cochleostomy classifications detailed in the Methods section, the majority of surgeons (76.4%) selected an inferior or anterior cochleostomy location for image 1. Correspondingly, the majority of surgeons (83.6%) also chose cochleostomy locations classified as either inferior or anterior in image 3. However, 23.6% and 16.4% of surgeons chose superior cochleostomy locations for images 1 and 3, respectively. Also, most (57.9%) of the surgeons who indicated that the exposure in question 11 was adequate chose an inferior location for the cochleostomy.

Correlations Between Surgical Images

Seventy-eight percent of surgeons who selected an inferior cochleostomy in image 1 also chose an inferior location in image 3, while the remaining 21.7% chose an anterior location in image 3. On the other hand, if surgeons selected a superior cochleostomy location in image 1, 53.8% also chose a superior location in image 3, while

the remaining selected an anterior location. Again, surgeons who selected a superior location in image 1 and an inferior one in image 3, or the reverse, were excluded from this evaluation.

In 37 participants, a good correlation between the surgical images was observed (for example, similar cochleostomy locations in images 1 and 3). Surgeons who used inferior cochleostomies also indicated that they drill smaller openings (mean cochleostomy diameters of 1.41, 1.32, and 1.14 mm for superior, anterior, and inferior locations, respectively). They were also more likely to drill the round window overhang (43%, 50%, and 78% for superior, anterior, and inferior locations, respectively) than surgeons who used superior cochleostomies. However, those differences did not reach statistically significant levels. Statistically significant levels were observed between question 11 (rating the exposure in image 2) and the cochleostomy location for images 1 and 3. Specifically, 83% of surgeons who selected superior cochleostomies rated the exposure in image 2 as adequate opposed to only 17% and 33% for surgeons selecting anterior and inferior locations, respectively.

Influence of the Surgical Case Volume

The number of implantations per year was correlated to the site of the cochleostomy in relation to the round window niche. Two of 12 (16.7%) busy surgeons from the 50+ group (who performed 50 or more implantations/year) used a superior cochleostomy in image 1, and 1 (8.3%) of these surgeons also selected a superior location in image 3. In the group of non-busy surgeons (group 0–10 implantations/y, $n = 7$), 57.1% (4 of 7) and 28.6% (2 of 7) of

surgeons selected superior cochleostomies in image 1 and 3, respectively.

Also, the influence of surgical case volume on facial and chorda tympani nerve identification, round window niche drilling, and cochleostomy location was assessed. As expected, the percentage of busy surgeons (50+ group) who routinely identify the facial nerve was 91.7% (11 of 12). Respective numbers were 42.9% for those performing 30 to 50 implants/year, 66.7% for those doing 20 to 30 implants/year, 42.9% for the 10 to 20 implants/year group, and 85.7% for the group of surgeons with less than 10 implants/year. Similar values were seen for chorda tympani identification.

The percentage of surgeons drilling the round window overhang ranged from 28.6 to 71.4% with the value for busy surgeons of the 50+ group being 50.0% and that for the inexperienced group (0–10 implants/y) being 28.6%.

Correlations Between Variables

Correlations were calculated by means of non-parametric Spearman rank correlations. (Table II). Statistically significant relationships were present between the number of implantations per year (question 1) and the size of the cochleostomy burr (question 2, the more implants, the smaller the burr). Also, the number of implantations per year correlated with the size of the cochleostomy (question 7, the more implants, the smaller the cochleostomy) as well as the cochleostomy location in images 1 and 3 (superior cochleostomies with fewer implants per year). Further correlations were

found between questions 3 (burr size) and 4 (identification of the facial nerve, the smaller the burr, the higher the likelihood of visualizing the facial nerve). Also, the burr size correlated with the size of the cochleostomy (question 7). Further correlations were found between questions 6 (round window overhang drill-off) and 8 (drill through the round window membrane, when drilling through the round window membrane, most surgeons also drill off the overhang) as well as between questions 6 and the cochleostomy location in image 3 (question 12, superior cochleostomies more likely in surgeons who do not drill off the overhang). A clear correlation was found between surgical images 1 and 3.

DISCUSSION

Results of this survey document the broad spectrum of surgical techniques for cochlear implantation in North America. Despite this clear variability among surgeons, some variables demonstrated statistically significant relationships. For example, the size of the burr used for cochleostomy drilling correlated with the final size of the cochleostomy opening. More interesting, a small number of annual implantations was associated with a superior cochleostomy location and larger final opening size. Thus, more experienced surgeons tended to drill smaller and more inferior or anteroinferiorly located cochleostomies than did their less experienced peers, although exceptions did exist. This probably relates to the fact that experienced surgeons possess a more thorough knowledge of the surgical anatomy of the region, thus requiring less bony excavation for creating a precise scala tympani opening.

TABLE II.
Calculated Correlations (*P* Values of Spearman Nonparametric Correlations) Between Variables.

Variable	Variable Name	Correlation With									
		2: Burr	4: Facial Nerve	5: Chorda Tympani	6: Round Window Overhang	7: Size	8: Drill RW	9: RW Ins	10: Img 1	11: Img 2	12: Img 3
1	Number of cochlear implants/year (#)	.045*	.300	.307	.495	.006*	.550	.223	.017*	.479	.049*
3	Burr size for the cochleostomy (Burr)		.033*	.373	.730	.001*	.766	.562	.428	.694	.788
4	Identification of the facial nerve (FN)			.096	.461	.643	.585	.110	.311	.324	.414
5	Identification of the chorda tympani (CT)				.927	.646	.775	.422	.352	.828	.316
6	RW overhang drill off (RW OH)					.776	.022*	.081	.185	.781	.048*
7	Cochleostomy size (Size)						.241	.624	.122	.428	.066
8	Drill through part of the RW membrane (Drill RW)							.103	.859	.635	.900
9	Sometimes perform RW insertions (RW Ins)								.470	.167	.304
10	Cochleostomy location in image 1 (Img 1)									.387	.000*
11	Enough exposure in image 2 (Img 2)										.143
12	Cochleostomy location in image 3 (Img 3)										

*Statistically significant relationship (*P* < 0.05 indicates statistical significance).

FN = facial nerve; Img = image; RW = round window; RW OH = round window overhang.

Why surgeons would choose a cochleosotomy location superior to the round window membrane remains unclear. Previous studies suggest that inferior or anteroinferior cochleostomy locations usually provide an atraumatic path for access into scala tympani.⁹ On the contrary, drilling superior to the round window membrane features relatively blind drilling on the cochlear promontory, and probable electrode misplacement into either scala vestibuli or the vestibule, depending on the angle of descent. Deeper drilling in this region could also result in unwanted entrance into the cochlear modiolus and, ultimately, the internal auditory canal.

Overall, uniformity in scala tympani cochleostomy placement is lacking. This probably has resulted from the

general feeling that precise electrode location within the cochlea is unnecessary. Recent studies now suggest that electrode location should be within scala tympani, and that dislocations or placement of the array into scala vestibuli may result in worse outcomes.^{10,15} That scala vestibuli placements and cochlear duct transactions will produce a high likelihood of hearing loss also makes these locations unacceptable for hearing preservation surgeries.² Careful temporal bone dissection is needed among implant surgeons. Moreover, the need for studies demonstrating the topographical, surgical anatomy, and cochleostomy locations with the resulting intracochlear histopathology is needed. Aggressive dissemination of such information is also needed to make surgeons aware of these important techniques.

APPENDIX

PRESUMED LOCATION OF AN ATRAUMATIC COCHLEOSTOMY FOR COCHLEAR IMPLANTATION ...what answer fits best?

- How many cochlear implants do you do per year? 0-10 10-20 20-30 30-50 50+
- What drill do you usually use for drilling the cochleostomy? _____ Manufacturer/Type
- What size burr do you use for the cochleostomy? 0.6 0.8 1.0 1.2 1.5 2.0
- Do you routinely identify the facial nerve in the facial recess? yes no
- Do you routinely identify the chorda tympani? yes no
- Do you routinely drill-off a part of the round window-niche overhang? yes no
- What size is your final cochleostomy? 0.8 1.0 1.2 1.5 2.0
- Do you sometimes drill through a part of the round window membrane? yes no
- Do you sometimes perform round window insertions? yes no
- Where would you start to drill a cochleostomy for scala-tympani cochlear implant electrode insertion. Please choose the numbered spot that fits best:

...please check one:

1 2 3 4 5 6 7 8 9 10 11 12 13 14

- Would that be adequate exposure for routine scala tympani cochlear implantation?

Yes No

...if so, which number most accurately indicates where you would start drilling the cochleostomy:

1 2 3 4 5 6 7 8 9

- Where would you start to drill a cochleostomy for atraumatic cochlear implant electrode insertion in this temporal bone. Please choose the numbered spot that fits best:

...please check one:

1 2 3 4 5 6 7 8 9 10 11

Questionnaire handed out during the William House Study Club in Toronto, Canada.

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