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Evaluation of Outcome Variability Associated With Lateral Wall, Mid-scalar, and Perimodiolar Electrode Arrays When Controlling for Preoperative Patient Characteristics

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Objective: Determine the impact of electrode array selection on audiometric performance when controlling for baseline patient characteristics.
Study Design: Retrospective evaluation of a prospective cochlear implant (CI) database (January 1, 2012–May 31, 2017).
Setting: Tertiary Care University Hospital.
Patients: Three hundred twenty-eight adult CI recipients.
Interventions/Main Outcomes Measured: Hearing outcomes were measured through unaided/aided pure tone thresholds and speech recognition testing before and after cochlear implantation. All reported postoperative results were performed at least 6 months after CI activation. All device manufacturers were represented.
Results: Of the 328 patients, 234 received lateral wall (LW) arrays, 46 received perimodiolar (PM) arrays, and 48 received mid-scalar (MS) arrays. Patients receiving PM arrays had significantly poorer preoperative earphone and aided PTAs and SRTs, and aided Consonant-Nucleus-Consonant(CNC) word and AzBio +10 SNR scores compared with patients receiving LW arrays (all $p \leq 0.04$), and poorer PTAs and AzBio +10 SNR scores compared with MS recipients (all $p \leq 0.02$). No preoperative audiological variables were found to significantly differ between MS and LW patients. After controlling for preoperative residual hearing and speech recognition ability in a hierarchical multiple regression analysis, no statistically significant difference in audiological outcomes was detected (CNC words, AzBio quiet, or AzBio +10 SNR) among the three electrode array types (all $p > 0.05$).
Conclusion: While previous studies have demonstrated superior postoperative speech recognition scores in LW electrode array recipients, these differences lose significance when controlling for baseline hearing and speech recognition ability. These data demonstrate the proclivity for implanting individuals with greater residual hearing with LW electrodes and its impact on postoperative results.
Key Words: Cochlear implant—Hearing—Sensorineural hearing loss.

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Adult cochlear implant (CI) outcomes are known to be impacted by a number of factors including postlingual onset of deafness, age at implantation, duration of hearing loss, hearing aid use, and preoperative hearing level (1–6). Beyond patient specific factors that cannot be altered, differences in devices and their placement represent a potential source of postoperative outcome variability (7,8). Improvement in CI outcomes over time has been synchronous with refinement of surgical techniques and implant technology. Electrode design, intrascalar positioning, and atraumatic operative techniques are thought to be significant predictors of post-op speech recognition ability (5–7,9–14). Electrode array selection is one of the few modifiable aspects of CI surgery; however, the impact of this choice in relation to patient specific factors is an ongoing area of investigation.

Electrode arrays are ideally placed within the scala tympani (ST) and classified according to intrascalar position as either perimodiolar (PM), mid-scalar (MS), or lateral wall (LW). MS electrodes target an intermediate trajectory within the ST but are often considered a PM subcategory (15). Electrodes achieving a final position closer to spiral ganglion cells within Rosenthal's canal

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are thought to reduce compound action potential thresholds and cross channel interaction, transferring high definition electrical signal directly to neurons (16,17). When electrodes reside entirely within the ST, these features of PM arrays have been associated with increased word recognition ability (5,14). However, precurved arrays designed to hug the modiolar wall also have a higher incidence of intracochlear trauma, often due to scalar excursion into the scala vestibuli (SV) (13,14,18–21).

Reducing damage to intracochlear architecture is an area of increased focus due to implanting patients with a greater degree of residual hearing. Preserved low-frequency perception at the cochlear apex is the goal of such surgery, which allows electrical and acoustic stimulation resulting in superior speech understanding (17,22,23). Maintenance of functional hearing after surgery is more likely with the insertion of LW electrodes, which less commonly deviate from the ST (19–21). Thus, patients under consideration for CI may be separated into two categories: those with very poor hearing requiring optimal electrical stimulation, and those who may benefit from preserved residual hearing combined with electrical stimulation.

While superior postoperative CI speech recognition scores have been observed in patients utilizing a LW electrode (20), baseline patient characteristics likely influence preoperative therapeutic decisions, and accordingly, postoperative outcomes. We hypothesized that preoperative patient factors impact performance after implantation to a greater degree than electrode selection. The primary aim of this study was to determine if postoperative hearing scores vary between lateral wall, mid-scalar, and perimodiolar electrode array recipients after controlling for baseline hearing status.

MATERIALS AND METHODS

The study was approved by the Medical University of South Carolina IRB - Pro00071518 and consisted of adult CI patients from a single tertiary care institution. The Medical University of South Carolina Cochlear Implant Program maintains a prospective database for all of its CI patients. The current study is a retrospective analysis of adults with postlingual hearing loss who underwent cochlear implantation from January 2012 to May 2017. Exclusion criteria included: patients who underwent their initial CI surgery elsewhere thus preoperative data were not available, patients with incomplete audiometric data; patients who had revision CI surgery; and patients without a minimum of 6 months post-activation follow up speech recognition data. Patients were categorized by CI device and array style (LW, PM, or MS). All three current US-FDA approved implant manufacturers were represented. Choice of CI manufacturer was determined by the patient unless a medical reason existed to recommend one company over the others.

Demographic data including age, sex, ethnicity, insurer, preoperative hearing aid use, and duration of hearing loss were collected for patients meeting study criteria. Baseline hearing ability was assessed by pure-tone average (PTA), speech recognition thresholds (SRT), and Consonant-Nucleus-Consonant word scores (CNC) tested under earphone (supra-aural headphone or inserts) and aided conditions, and AzBio sentence scores in quiet and noise (multi-talker babble; +10 dB SNR) tested under aided conditions. Follow up speech recognition ability was tested using CNC, AzBio quiet, and AzBio +10 SNR (AzBio +10). For both aided and implanted conditions, AzBio +10 was used when individuals scored more than 50% on AzBio quiet. Reported pure-tone averages were calculated using the average air-conduction thresholds at 500, 1000, and 2000 Hz (24,25). Earphone CNC scores were obtained at uncomfortable loudness level (determine with speech signal) minus 5 dB SPL for all patients. Aided and implanted speech recognition testing was performed with speech presented at 60 dB SPL in the sound field in a sound treated room. Hearing aid users were tested with their personal hearing aids, while non-hearing aid users were provided stock hearing aids for testing. All hearing aids (personal and stock) were programmed to meet The National Acoustic Laboratories' Non-Linear (NAL-NL) target thresholds before testing.

Statistical Analysis

Simple descriptive statistics such as frequency, percentage, mean, standard deviation, standard error, minimum, and maximum were calculated for all outcome variables. Statistical analyses of baseline demographic and audiologic data were performed using χ^2 test or Fisher's exact test for nominal variables and a one-way analysis of variance followed by a Tukey posthoc comparison test, if needed, for continuous variables. Pre- to postoperative differences in CNC, AzBio quiet, and AzBio +10 scores within each electrode group were assessed using paired *t* tests, and speech recognition differences between electrode array groups at pre- and postoperative time points were analyzed by one-way analysis of variance (ANOVA). A one-way analysis of covariance (ANCOVA) was conducted for each of the three tests of speech recognition to determine any statistically significant differences in postoperative speech recognition between electrode styles after controlling for baseline hearing status. Corresponding preoperative scores were used as covariates to determine estimated marginal means adjusted for baseline speech recognition and reveal the percent of variance in outcomes attributable to baseline hearing status.

Hierarchical Multiple Regression

Following a review of relevant assumptions for statistical analysis, hierarchical multiple linear regression was conducted to determine whether electrode selection explained unique variance in postoperative speech recognition after controlling for baseline hearing status. Hierarchical regression determines whether independent variables of interest predict the dependent variable above and beyond the effect of pre-existing factors. Separate ordinary least squares regression models are built in each step and compared to determine if the successive model's fit is superior to the first. Postoperative CNC, AzBio quiet, or AzBio +10 scores were used as the dependent variable, and electrode type and preoperative audiometric variables found to correlate with postoperative CNC, AzBio quiet, or AzBio +10 were used as independent variables. A two-stage hierarchical linear regression was performed for each postoperative test of speech recognition. Because hearing status necessarily preceded CI consideration and its potential influence on electrode selection, preoperative speech recognition was entered as the first step in the regression equation and electrode category was entered as the second step.

Pre-op aided CNC and AzBio quiet were correlated with an r value of 0.813. Correlations between other independent variables met the assumption of singularity (all r <0.7), and collinearity statistics (i.e., tolerance and variance inflation factor) for all variables were all within limits to meet the assumption of multicollinearity. Five multivariate outliers in the regressions for postoperative CNC and six outliers in the regression for AzBio quiet were identified based on Mahalanobis distance scores which were removed from the data set. Assumptions of normality, linearity, and homoscedasticity were assessed via residual and scatter plots and found to be satisfied. Missing values were excluded pairwise. To maintain a subject-to-variable ratio more than or equal to 15:1, preoperative AzBio +10 scores were excluded from regressions. A p value of <0.05 was considered to indicate a statistically significant difference for all statistical tests. All statistical analysis was performed using SPSS version 24.0 (IBM Corp., Armonk, NY), SigmaPlot 12.5 (Systat Software, San Jose, CA), and MedCalc 17.9.7 (MedCalc Software, Oostende, Belgium).

RESULTS

Three hundred twenty-eight CI recipients met inclusion criteria. Patients were 55.5% men, and the average age at implantation was 63.7 ± 16.7 years (range, 19–94 yr). The mean duration of hearing loss before implantation was 24.2 ± 17.2 years, and 64.9% of patients used a hearing aid on the implanted side preoperatively. Two hundred thirty four (71.3%) received LW arrays, 46 (14.0%) received PM arrays, and 48 (14.6%) received MS arrays. Age, sex, ethnicity, insurance, preoperative hearing aid use, and duration of hearing loss did not significantly differ between electrode array groups (Table 1).

Preoperative Performance

Tables 2 and 3 display demographic and audiologic data based on electrode array group. Overall, patients in the PM group had worse preoperative hearing than the LW group. The PM group had higher mean earphone and unaided PTAs and SRTs and lower aided CNC and AzBio +10 scores (all $p \leq 0.036$). Although MS and PM electrodes were both selected for patients with worse hearing, MS recipients' aided and earphone PTA and AzBio +10 scores were significantly better than those of PM patients (all $p \leq 0.024$). Preoperative hearing status did not significantly differ between MS and LW recipients.

Postoperative Performance

Postoperative CNC, AzBio quiet, and AzBio +10 scores were significantly improved from baseline following implantation in all electrode groups (all $p < 0.001$). LW array recipients' postoperative CNC, AzBio quiet, and AzBio +10 scores compared favorably to patients implanted with PM or MS electrodes. However, only the improved AzBio +10 scores of LW patients over those implanted with MS arrays reached significance ($p = 0.007$). When postoperative mean scores were adjusted for covariance in baseline speech recognition ability in the ANCOVA to calculate estimated marginal means, no significant differences in postoperative performance were detected between electrode types (all $p \geq 0.074$). Adjustment for preoperative covariance yielded higher scores for PM patients and lower scores for LW and MS patients compared with actual postoperative performance. This indicates that by accounting for preoperative hearing status, the mean differences in CNC, AzBio quiet, and AzBio +10 scores between

TABLE 1. *Summary of patient characteristics*

Variable	All	Lateral Wall	Perimodiolar	Mid-scalar	*p*-value
Number	328	234	46	48	
Age (mean ± SD range)	63.7 ± 16.7 (19–94)	64.2 ± 16.1 (19–91)	61.1 ± 17.6 (23–90)	64.1 ± 18.6 (18–94)	0.50
Gender					
Male	182 (55.5%)	128 (54.7%)	23 (50.0%)	31 (64.6%)	0.33
Female	146 (44.5%)	106 (45.3%)	23 (50.0%)	17 (35.4%)	
Race					
White	278 (84.8%)	198 (84.6%)	38 (82.6%)	42 (87.5%)	0.55
African American	48 (14.6%)	35 (15.0%)	8 (17.4%)	5 (10.4%)	
Asian	2 (0.6%)	1 (0.4%)	0	1 (2.1%)	
Hearing aid use					
Yes	213 (64.9%)	159 (67.9%)	27 (58.7%)	27 (56.3%)	0.17
No	110 (33.5%)	70 (29.9%)	19 (41.3%)	21 (43.8%)	
Unknown	5 (1.5%)	5 (3.1%)	0	0	
Duration of hearing loss	24.2 ± 17.2	24.5 ± 17.1	23.8 ± 16.5	23.1 ± 18.4	0.87
Insurance					
Medicare	204	145	27	32	0.56
Medicaid	18	14	2	2	
Private	91	66	14	11	
Tricare	6	3	3	0	
Vocal Rehab	4	3	0	1	
Work Comp	3	3	0	0	

TABLE 2. *One-way analysis of variance (ANOVA) of baseline hearing*

	Variable	All	Lateral Wall	Perimodiolar	Mid-scalar	F	p-value++
Unaided (mean ± SD)	PTA	87.6 ± 18.7	86.7 ± 18.3	96.3 ± 19.4	83.5 ± 18.2	6.574	<0.00* [1] 0.004* [2] 0.517 [3] 0.003*
	SRT	75.0 ± 17.2	73.7 ± 18.1	81.2 ± 14.1	76.4 ± 14.1	3.278	0.04* [1] 0.036* [2] 0.580 [3] 0.411
	CNC	12.9 ± 17.8	13.3 ± 17.7	8.3 ± 16.7	15.3 ± 18.4	2.020	0.13
Aided (mean ± SD)	PTA	45.2 ± 18.5	43.1 ± 16.3	54.5 ± 24.6	46.1 ± 19.9	7.063	<0.00* [1] 0.001* [2] 0.594 [3] 0.001*
	SRT	41.5 ± 12.0	39.9 ± 10.4	47.0 ± 16.0	44.5 ± 13.4	7.464	<0.00* [1] 0.002* [2] 0.052 [3] 0.612
	CNC	7.2 ± 11.5	8.0 ± 12.1	2.8 ± 5.9	7.8 ± 11.7	4.020	0.02* [1] 0.014* [2] 0.994 [3] 0.088
	AzBio Quiet	9.8 ± 14.8	10.4 ± 14.8	5.0 ± 10.3	11.9 ± 18.2	2.792	0.06
	AzBio +10	14.8 ± 15.6	18.4 ± 16.4	0.1 ± 0.3	16.1 ± 11.8	7.268	<0.00* [1] 0.001* [2] 0.872 [3] 0.024*

AzBio indicates sentence recognition in quiet; AzBio +10, sentence recognition in noise; CNC, consonant-nucleus-consonant word recognition; LW, lateral wall; MS, mid-scalar; PM, perimodiolar; PTA, pure-tone average; SRT, speech recognition threshold.
*Indicates statistical significance.
++Comparison 1 = LW × PM, 2 = LW × MS, and 3 = PM × MS.

LW and PM recipients fell from 4.5% to 2.6%, 1.3% to 0.0%, and 13.9% to 2.4%, respectively. Despite poorer preoperative performance, PM recipients outperformed MS patients after implantation, and comparison of estimated marginal means further expounded the relatively larger performance gain with PM arrays (Table 3). Speech recognition results were not found to significantly differ on the basis of CI manufacturer (Table 4).

Hierarchical Multiple Regression

We hypothesized that postoperative speech recognition testing would positively correlate with preoperative CNC, AzBio quiet, and AzBio +10 scores, and negatively correlate with PTA and SRT in both aided and earphone conditions. To build our multiple regression models, univariate correlations were first performed (Table 5). Preoperative audiologic data showed the strongest correlation with postoperative AzBio +10 scores. Aided CNC and AzBio +10 scores positively correlated with postoperative AzBio +10 scores. As expected, aided PTA and SRT negatively correlated with postoperative AzBio +10 scores.

Due to the clear electrode design difference between LW and PM arrays, these groups were selected to compare in the hierarchical multiple regression. Correlated preoperative scores from Table 5 were entered as the first step, and whether the patient received a LW or PM array

TABLE 3. *One-way analysis of variance (ANOVA) and covariance (ANCOVA) of postoperative hearing*

Variable	All	Lateral Wall	Perimodiolar	Mid-scalar	F	p-value++	Effect Size
CNC	40.5 ± 20.8	41.8 ± 21.1	37.3 ± 19.2	37.7 ± 20.7	1.524	0.219	0.009
ANCOVA		41.5 emm	38.9 emm	37.4 emm	0.950	0.388	0.006
AzBio Quiet	54.5 ± 27.3	55.6 ± 27.4	54.3 ± 29.7	49.2 ± 24.0	2.170	0.116	0.013
ANCOVA		55.5 emm	55.5 emm	48.7 emm	1.079	0.341	0.008
AzBio +10	49.8 ± 23.4	55.3 ± 23.0	41.4 ± 22.9	35.4 ± 19.1	5.279	0.007* [1] 0.219 [2] 0.007* [3] 0.528	0.095
ANCOVA		53.6 emm	51.2 emm	32.6 emm	2.780	0.074	0.125

AzBio +10 indicates sentence recognition in noise; AzBio, sentence recognition in quiet; CNC, consonant-nucleus-consonant word recognition; emm, estimated marginal mean.
*Indicates statistical significance.
++Comparison 1 = LW × PM, 2 = LW × MS, and 3 = PM × MS.

TABLE 4. *Postoperative scores by CI manufacturer*

Variable	MED-EL	Advance Bionics	Cochlear Americas	*F*	*p*-value
CNC	(103) 37.9 ± 18.7	(55) 38.4 ± 21.2	(167) 43.2 ± 21.8	2.498	0.084
AzBio Quiet	(102) 54.9 ± 26.1	(56) 51.3 ± 25.6	(165) 59.9 ± 28.2	2.520	0.082
AzBio +10	(22) 42.0 ± 22.7	(24) 35.4 ± 20.9	(58) 47.6 ± 21.2	2.796	0.066

AzBio +10 indicates sentence recognition in noise; AzBio, sentence recognition in quiet; CI, cochlear implant; CNC, consonant-nucleus-consonant word recognition.

TABLE 5. *Correlation of pre- and postoperative hearing performance*

		Post-op CNC			Post-op AzBio Quiet			Post-op AzBio +10		
Pre-op Variable		N	Pearson *R*	*p*-value	N	Pearson *R*	*p*-value	N	Pearson *R*	*p*-value
Unaided (mean ± SD)	PTA	324	−0.138	0.013	322	−0.144	0.010	104	−0.106	0.282
	SRT	295	−0.100	0.087	294	−0.152	0.009	97	−0.221	0.030
	CNC	316	0.216	0.000	316	0.179	0.001	101	0.029	0.776
Aided (mean ± SD)	PTA	316	−0.175	0.002	315	−0.167	0.003	102	−0.265	0.007
	SRT	282	−0.176	0.003	284	−0.143	0.016	93	−0.227	0.029
	CNC	323	0.199	0.000	322	0.175	0.002	103	0.279	0.004
	AzBio Quiet	287	0.114	0.054	285	0.131	0.027	74	0.080	0.501
	AzBio +10	63	0.291	0.021	64	0.196	0.120	43	0.365	0.016

AzBio +10 indicates sentence recognition in noise; AzBio, sentence recognition in quiet; CNC, consonant-nucleus-consonant word recognition; PTA, pure-tone average; SRT, speech recognition threshold.

was entered as the second step in the hierarchical equations for postoperative speech recognition. This two-step design explored whether array selection impacted postoperative speech recognition after controlling for baseline hearing performance. Hierarchical multiple linear regression of pre- and postoperative speech recognition for LW and PM recipients revealed, preoperative performance contributed significantly to the regression model for all three measures of postoperative speech recognition, accounting for 9.7%, 9.2%, and 14.1% of the variation in postoperative CNC, AzBio quiet, and AzBio +10 scores, respectively (all $p \leq 0.035$). When controlled for preoperative performance, electrode selection was not found to significantly impact any postoperative measures of speech recognition (Table 6).

DISCUSSION

Given the propensity at our institution and others to implant patients with greater residual hearing with LW electrodes versus PM or MS arrays, we expected to find significant preoperative hearing differences among these groups. Our analysis revealed significant differences in preoperative hearing status between LW and PM groups. LW patients had significantly better PTAs and SRTs than PM patients and significantly outperformed PM patients on CNC and AzBio +10 testing preoperatively (Table 2). The overall superior hearing preoperatively noted in the LW group compared with the PM and MS groups, again, was not surprising given the tendency at our institution to choose a LW array for patients with greater residual hearing. Our data are consistent with at least two other studies comparing LW and PM array performance, where the authors similarly noted better preoperative hearing in the LW groups (20,26).

The greater pliability of the LW implant than the more rigid, precurved PM array is thought to make it less likely to translocate into the SV, thereby avoiding damage to the basilar membrane, Reissner's membrane and organ of Corti, and increasing the likelihood of preserving residual

TABLE 6. *Hierarchical multiple regression of baseline hearing performance and electrode type*

Variable	Step[a]	*R* Square	*R* Square Change	*F* Change	df1	df2	Sig. *F* Change
CNC	Step 1	0.097	0.097	3.651	6	201	0.002
	Step 2	0.098	0.001	0.039	1	200	0.843
AzBio Quiet	Step 1	0.092	0.092	2.485	8	197	0.014
	Step 2	0.093	0.001	0.296	1	196	0.587
AzBio +10	Step 1	0.141	0.141	2.538	5	77	0.035
	Step 2	0.149	0.007	0.651	1	76	0.422

AzBio +10, sentence recognition in noise; AzBio, sentence recognition in quiet; CNC, consonant-nucleus-consonant word recognition.
[a]Step 1 = correlated speech recognition tests (excluding AzBio +10) and Step 2 = array selection.

hearing (19,26,27). Given the increased likelihood of hearing preservation with a LW electrode, at our institution and others, there has traditionally been a tendency toward choosing a LW electrode over a PM array in those patients with more intact preoperative hearing levels. Conversely, in patients who retain little to no residual hearing preoperatively, a PM electrode is chosen with its precurved design providing the hypothetical advantage of greater electrode apposition to the spiral ganglion neurons, less energy usage, and greater overall speech understanding. Acknowledging LW electrodes are typically chosen for patients with greater preoperative hearing and postoperative CI performance correlates with preoperative hearing status, it is therefore tenable that LW electrodes would be expected to have improved postoperative hearing outcomes. It was our intent to determine if this expectation is valid when preoperative hearing status is considered.

We did not find any significant differences in postoperative performance based on electrode type. However, we did find that preoperative hearing status had a greater impact on postoperative outcomes than electrode array selection. Prior studies have reported inconsistent hearing outcomes for recipients of differing arrays. Some have been in agreement with the results of the present study, reporting no significant differences among the electrode styles (28–30), while others have supported a hearing advantage with either the PM (31) or LW (20) electrode. The recent study by O'Connell et al. (20) found significantly higher CNC and AzBio scores in LW compared with PM arrays, which was attributed to lower rates of implant extrusion into the SV for the LW cohort. A significant limitation to our study, and most studies evaluating CI outcomes, is the lack of knowledge of electrode location within the cochlea and the rates of array extrusion from the ST into the SV. Unfortunately, this technology is not routinely available for clinical use and there is no clinical intervention for patients where array extrusion is seen. A number of studies have previously shown that LW electrodes are more likely to solely reside in the ST than other array designs. This is presumed to result in better performance as electrodes residing entirely in the ST correlate with better hearing outcomes (14,28). Wanna et al. (14) compared outcomes between LW and PM electrodes and found more LW electrodes (89%) resided completely within the ST than their PM counterparts (58%), and that electrodes residing solely within the ST had better postoperative mean CNC-word performance (48.9%) than those located outside the ST (36.1%). Additional work by this group, compared electrode types (LW, PM, MS), their likelihood to reside within the ST, and associated hearing performance (28). This revealed that PM and MS arrays were 22 and 55 times more likely to have electrodes residing outside of the ST than LW arrays, respectively. Furthermore, SV insertion was associated with a 12% decrease in CNC score. However, consistent with our findings, when simply evaluating outcomes based on electrode array type, irrespective of electrode location, there were no significant differences in CNC scores found (28). Therefore, it is possible that LW electrodes do have a positive impact on CI outcomes, but only when inserted entirely within the ST. However, further data are required to evaluate the influence of individual pre-operative audiologic data on this statement.

While the impact of electrode array selection on audiometric performance has been assessed in previous articles, and some evidence has suggested a performance benefit in patients with lateral wall electrodes due to less frequent translocations out of the ST, previous studies do not adequately control for baseline hearing. The present study represents the first time the outcomes of a very large population of CI recipients from all three FDA approved implant manufacturers have been controlled for preoperative hearing status in a modern statistical manner.

Despite similar postoperative hearing outcomes between our LW and PM groups, we performed a hierarchical multiple regression analysis of pre- and postoperative speech recognition for LW and PM implantees to identify the contribution of the observed preoperative hearing differences on the postoperative audiometric results. Confirming our hypothesis, the regression analysis revealed that preoperative differences had a significant impact on postoperative hearing scores. We noted that preoperative aided CNC, AzBio quiet, and AzBio +10 scores contributed significantly to the regression model, accounting for 9.7, 9.2, and 14.1% of the variation in postoperative CNC, AzBio quiet, and AzBio +10 scores, respectively. Again, when controlled for preoperative performance, electrode selection was not found to significantly impact any postoperative measures of speech recognition.

There were a number of limitations to our study. The study was performed in a retrospective fashion which is suboptimal for comparative studies and introduces the potential for bias. Patients in this study were treated by four different surgeons, all with subtle differences or nuances of surgical techniques and approaches to hearing preservation during cochlear implantation. Although diversity in technique/device choice allows greater generalizability, all patients were also treated at a single institution, which may limit the applicability of our results to implant programs with distinctly different tendencies in the use of each electrode type. As previously mentioned, imaging data to confirm electrode placement were not available for comparison; however, the rate of electrode transgression into the SV in the study population would not be expected to significantly differ from previous research.

CONCLUSION

The optimal cochlear implant array design that confers the greatest hearing benefit to patients has yet to be fully clarified. Growing evidence supports arrays residing solely within the ST as likely outperforming those that have translocated into the SV, and both cadaveric and in-vivo electrode localization studies have now shown LW arrays being most likely to remain in the ST. Before accepting LW arrays as being the most favorable design, however, it is prudent to directly correlate improved hearing outcomes with these arrays over their counterparts. Our study underscores the proclivity for implanting better hearing patients with LW arrays and the impact this selection bias has on comparative hearing outcomes analysis between LW and PM or MS implantees. Moving forward, it is imperative for future studies comparing hearing performance between array designs to consider underlying preoperative auditory discrepancies among these groups. Further investigation will continue to be crucial in bettering our understanding of how array design and intracochlear electrode location may render improved hearing outcomes after implantation.

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