Original Article

Automated Real Ear Measures (AutoREM)-Based Hearing Aid Fitting in Adults Sensorineural Hearing Loss Patients

Marwa Khaled Osman El Sayed, Dalia Mohamed Hassan, Noha Ali Shafik and Abeer Mohamed Mohamed EL-Gendy

Department of ENT Audiology Unit, Faculty of Medicine, Ain Shams University

ABSTRACT

Background: Hearing aid fitting guidelines recommended the use of real ear measures (REM) as a verification step during hearing aid fitting process. The clinician will in turn readjust the hearing aid based on REM to reach prescriptive fitting targets. Unfortunately, approximately 70 to 80% of clinicians do not use REM based fitting. In order to increase the clinical use of REMs, hearing aid manufacturers developed integrated REMs (Auto REM) in the fitting software with subsequent automatic fitting to target.

Aim of the Work: To compare the AutoREM-based hearing aid fitting and the manufacturer's first-fit approaches objectively and subjectively in order to Prove efficacy.

Materials and Methods: The study was conducted on thirty eight adult subjects in Audiology Unit-Ain Shams University hospitals, with mild to moderately severe sensorineural hearing loss. All subjects were fitted with Bernafon " Zerena 9 RIC-100" monaurally. The hearing aid was adjusted by manufacturer's first fit then Auto-REM based fitting. Then it was evaluated objectively by Real ear measurement and subjectively by aided thresholds, speech recognition score and word recognition scores.

Results: AutoREM-based fitting had statistically significant better pure tone aided thresholds, higher word recognition scores (WRS) and higher gain by real ear insertion gain (REIG) than the First fit.

Conclusion: AutoREM-based fitting proved to be beneficial step in hearing aid fitting in adults as it provides perfect match to the recommended target gain. It should be implemented in the fitting process whenever possible particular in difficult to test population.

Key Words: FF, REIG, REM.

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Corresponding Author: Marwa Khaled Osman Elsayed, M.B.B.CH Faculty of Medicine Ain Shams University, Cairo, Egypt. **Tel.:** +201147013447, **E-mail**: k.marwa56@yahoo.com

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INTRODUCTION

The most important part of fitting hearing aids is making sure that the assisted output is acceptable across frequencies in order to optimize the potential benefits of amplification[1]. In the discipline of audiology, real-ear measurements, or REMs, have been acknowledged as best practices. They offer a means of gauging the effectiveness of hearing aids in the ear, which can result in more precise and customized fittings, improving both the listening and fitting experiences[2].

The patient could not acquire the best speech audibility if the gain/output is not checked using REM to closely match a prescriptive objective[3].

First-Fit settings can diverge greatly from prescribed targets, according to studies. Software simulation is the foundation of the First-Fit. Nonetheless, it is recognized that these corrective factors differ significantly throughout people and hearing aid fittings[4]. Therefore, when employing the First-Fit based fitting, output deviations from prescriptive targets can still be seen in certain individuals. Thus, using REMs enhances the prescription targets' fit, resulting in a good listening outcome[5].

The automatic communication between the probe-mic equipment and the software for fitting hearing aids has drawn more attention in recent years[6]. "autoREMfit" is the term for this procedure[7]. The idea behind autoREMfits is that the REM verification equipment and the hearing aid software exchange measurements. Based on the difference

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between the desired (target) output and the real-time measured output, the autoREMfits software automatically adjusts the HA programming (gain corrections) until the target is reached[6]. This expedites and streamlines the procedure, which promotes the use of REM in the fitting and verification of hearing aids[7].

Time constraints are the key reason why clinicians do not frequently administer REM despite research data and clinical practice standards. Regrettably, hearing aid users report unequal advantages and greater variances in assisted function when REM is not used. However, it is yet unknown if the enhanced prescription target match that AutoREM-based fitting produces automatically will lead to better patient outcomes and acceptance enough to incorporate it into HA fitting sessions on a regular basis[8].

AIM OF THE WORK

In order to demonstrate efficacy, REMs are used to match prescription targets better, resulting in better listening outcomes. Additionally, AutoREM-based hearing aid fitting and First-fit techniques are compared both objectively and subjectively.

Methodology:

Study population: Thirty-eight patients, or forty ears, were studied in the Audiology Unit at Ain shams hospitals.

Ethical considerations:

The study was carried out with permission from the research ethics committee; the approval number was FMASU MS 129/2023 on August 3, 2023.

Criteria for selection:

- **Inclusion Criteria:**

Age ranged from 18 to 60 years with unilateral or bilateral HL, symmetrical or asymmetrical or any configuration either first time or experienced hearing aid user.

- **Exclusion Criteria:**

Patients with impacted cerumen, external ear anomalies, collapsed or narrow canal, otitis Externa or middle ear discharge, conductive and mixed hearing loss.

Methods:

All patients were subjected to the following :

Detailed audiological history

Otological Examination: To exclude any external or middle ear pathologies.

Basic Audiological Evaluation including: Pure tone audiometry for air conduction at frequencies between 250 and 8000 Hz and for bone conduction at frequencies between 500 and 4000 Hz, Speech audiometry includes speech discrimination scores using adult Arabic phonetically balanced monosyllabic words[9], and speech reception threshold (SRT) using Arabic spondee words[10].

Hearing aid fitting: Utilizing the receiver-in-the-canal (RIC) Bernafon Zerena 9 hearing aid.Two fitting procedures that were allocated in a random order were used to program the hearing. The audiogram-based First Fit fitting approach is used in the first fitting method; the built-in AutoREM is used in the second method to automatically increase gain to meet predetermined amplification targets.

HA verification measures: Using Aided sound field threshold test using warble tones at frequencies from 250-8000 Hz, Aided SRT using Arabic adult bisyllabic word list, aided discrimination using adult PB word list and Real ear insertion gain 65 dBSPL using ISTS

Statistical Analysis

A PC was used to review, code, tabulate, and import the gathered data using the IBM SPSS 20.0 statistical software for social sciences. The mean, standard deviations, and ranges of the quantitative data with a parametric distribution were displayed. Quantitative variables were also shown as percentages and numbers. The statistical significance of the difference in a parametric variable between two means of a single research group before and after the intervention was evaluated using the Paired Sample T-test. The following *p-value* was regarded as significant: *P-values* greater than 0.05 indicate non-significantness (NS), 0.05 indicates significance (S), and 0.01 indicates highly significance (HS).

RESULTS

38 participants (40 ears) with bilateral symmetrical or asymmetrical sensorineural hearing loss—25 symmetrical and 15 asymmetrical—with mild to moderately severe hearing loss participated in the study.Their mean age was 43 years ± 17, and they were divided into 24 males (60%) and 16 females (40%). Their ages ranged from 18 to 60 years.

The study group consisted of about half previous users of HA, with an average duration of 15.64 years ±12.9, ranging from 0.25 to 48 years. The majority of them were consistent users of hearing aids who responded well.

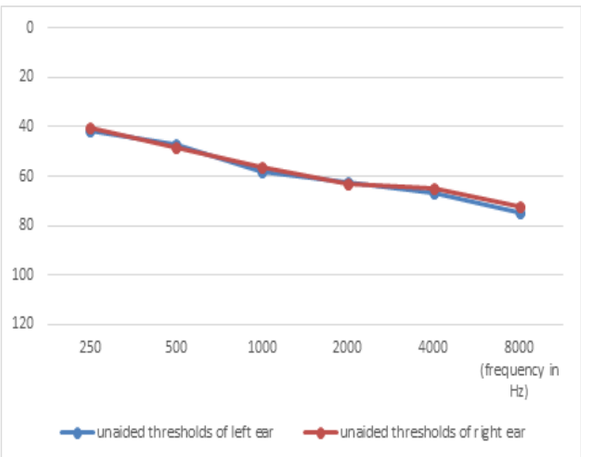

Fig. 1: Mean of unaided hearing thresholds of both ears across frequencies in the study group.

Table 1: Distribution of the study group subjects according to the degree and configuration of hearing loss:

		n=40	Percentage (%)
Degree of hearing loss	Mild	3	7.5%
	Moderate	10	25%
	Moderately Severe	27	67.5%
Configuration of hearing loss	Sloping	26	65.0%
	Saucer	5	12.5.%
	Rising	1	2.5%
	Flat	8	20.0%

According to (Table 1), most research group ears exhibited moderately significant hearing loss, with a tendency toward higher frequencies (sloping arrangement).

As demonstrated in (Tables 2 and 3), autoREM-based fitting outperformed first fit statistically significantly in terms of better aided pure tone thresholds, higher WRS%, and higher real ear insertion gain at moderate input levels across all evaluated frequencies.

Table 2: Paired t-test between First fit (FF) and AutoREM-based fitting as regards pure tone aided thresholds across different frequencies, SRT and WRS.

Frequencies	First fit *n*=40	AutoREM-based fitting *n*=40	Paired t-test	*P-value*
	Mean ±SD	Mean ±SD		
250 Hz	25.6 ±10.8	23.8± 8.6	1.922	.062
500 Hz	30.5± 8.2	26.5 ±7.7	4.365	.000**
750 Hz	32.3 ±6.4	29 ± 7	4.038	.000**
1000 Hz	30.8 ±6.4	27 ±7.4	5.649	.000**
1500 Hz	33 ±5.8	28.4 ± 6.4	5.867	.000**
2000 Hz	34.5 ±7	27.8 ±6.5	7.940	.000**
3000 Hz	40 ±7.4	33.8 ±6	7.319	.000**
4000 Hz	42.4 ±8.7	34.9± 9.2	9.142	.000**
SRT	32 ±7.6	29 ± 6	4.309	.000**
WRS	78.2 ±13.9	82.4 ±11.9	-4.760	.000**

(**) Highly statistically significant at $P<0.01$

(Table 2) showed that AutoREM-based fitting had significantly better aided pure tone thresholds at frequencies from 500 to 4000 Hz, lower SRT with higher WRS than the First fit.

Table 3: Paired t-test between First fit and AutoREM-based fitting as regards Real ear insertion gain at 65dBSPL.

Frequencies	First fit *n*=40	AutoREM-based fitting *n*=40	Paired t-test	*P-value*
	Mean ±SD	Mean ±SD		
250 Hz	11 ±8.1	13.4 ±8.5	-3.033	.004**
500 Hz	17.1 ±9.5	20.3 ±9.5	-3.783	.001**
750 Hz	22.3 ±8.1	24.3± 8.2	-2.687	.011*
1000 Hz	25.2 ±7.7	27.6 ±7.3	-4.188	.000**
1500 Hz	25.5 ±7.8	30.1 ±7.5	-6.296	.000**
2000 Hz	25 ±8.3	30.4± 6.9	-8.632	.000**
3000 Hz	23.3 ±7.6	27± 6.7	-6.348	.000**
4000 Hz	20.4 ±8	25.2± 7.4	-5.762	.000**
6000 Hz	17 ±12.5	24 ±9.9	-5.318	.000**
8000 Hz	2.6±10.9	9.3 ±12.9	-4.731	.000**

(*) Statistically significant at $P<0.05$; (**) Highly statistically significant at $P<0.01$

AutoREM-based fitting had significantly higher real ear insertion gain at moderate input levels across all measured frequencies compared to First fit.

DISCUSSION

The purpose of this study was to find out how beneficial it is to use "AutoREM" when fitting hearing aids Hopefully, this will help in decreasing output variations from target across individuals. If successful, this could be especially useful for test subjects or young people who are unable to provide an unbiased assessment of how well a hearing aid is adjusted.

Compared to the First fit, AutoREM-based fitting in this investigation produced considerably better aided pure tone with greater WRS (Table 2).

The Speech Intelligibility Index (SII) was measured by ***Folkread et al.***[11]. Comparing VerifitLINK and Clinician Fit to First Fit, the results indicated that they improved SII scores.

In this study AutoREM-based fitting showed significantly higher real ear insertion gain at moderate input levels across all measured frequencies compared to First fit (Table 3).

Hawkins and Cook[12] compared measured 2cc coupler and real-ear insertion gain values to hearing aid fittings that were simulated using the manufacturers' fitting software. According to the authors, fitting software overestimated both the actual real-ear gain and the actual 2cc coupler gain of the hearing aids, notably in the higher and lower frequencies. It was implied that providers of hearing aids shouldn't count on their devices producing the kind of profit that fitting software predicts.

In agreement, numerous studies confirmed that the manufacturer’s initial-fit algorithm often is an inadequate amplification prescription, sometimes providing less-than-prescribed gain in the high frequencies by as much as 20 dB[13,4].

Similarly, Narayanan and Manjula[14] found that the mean REAR and REIG measured with First-Fit across frequencies were less than the optimized-fit using REM.

A developing trend is automated REMs that can be carried out within the fitting program. The makers of hearing aids anticipate that by removing some of the obstacles to conducting REMs, like time limits, these techniques will satisfy the needs of the clinician. The usage of REMs in hearing aid fitting procedures will rise as a result of the availability of these fitting solutions. While enabling the use of best practice verification processes during the fitting of hearing aids, the automated match-to-target technique frees up clinician time for other elements of clinical practice.

A professional audiologist's job is to close the gap between a patient's hearing impairment, needs, and the technological challenges of hearing aids by prescribing the right equipment and implementing follow-up outcome measurements.

CONCLUSION

AutoREM-based fitting will help in decreasing output variations from target across individuals and this will help in increasing the clinical use of REM.

DISPUTE OF INTEREST

The writers say they have no competing interests.

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دور قياسات الاذن الحقيقية التلقائي فى ضبط المعينة السمعية للبالغين المصابين بفقدان السمع الحسي العصبي

داليا محمد حسن، نهي علي شفيق، عبير محمد محمد الجندي و مروة خالد عثمان السيد

قسم السمعيات، كلية الطب، جامعة عين شمس

الخلفية: أوصت الإرشادات باستخدام مقاييس الأذن الحقيقية (REM) للتحقق من عملية ضبط المعينات السمعية، ليستخدمها الطبيب لتعديل ضبط المعينة السمعية. لكن لسوء الحظ، لا يستخدم ما يقرب من ٧٠ إلى ٨٠٪ من الأطباء مقاييس الأذن الحقيقية لضبط المعينة السمعية، ولكن بدلاً من ذلك يكتفون بالنهج الأولى المقترح من الشركة المصنعة. من أجل زيادة الاستخدام الاكلينيكى لمقاييس الاذن الحقيقيه، قام مصنعو المعينات السمعية بتطوير وإدماج وحدات مقاييس الاذن الحقيقيه داخل البرامج المستخدمة لضبط المعينات السمعية، مع اتاحة استخدام النتائج فى الضبط التلقائى للوصول الى المستوى المناسب لضبط المعينة السمعية.

المرضي وطرق البحث: ستقارن هذه الدراسة بين ضبط المعينة السمعية القائم على مقاييس الاذن الحقيقيه الالية مقابل الضبط القائم على النهج اللأولى للشركة المصنعة. سيتم تقييم النتائج بشكل موضوعي من خلال استخدام قياسات الأذن الحقيقية، وبشكل شخصي من حيث تقييم رضا المريض عن الضبط و قد تكون هذه الدراسة خطوة لتساعد على تطبيق مقاييس الأذن الحقيقية الألية بشكل روتينى فى ضبط المعينات السمعية فى المستقبل.

تم إجراء الدراسة على ثمانيه وثلاثون مريضًا (٤٠ اذن) بمتوسط عمر ٤٣±١٧ سنة وقد خضع جميع المرضي الي التاريخ المرضي التفصيلي، فحص الاذن، قياس السمع باستخدام النغمات النقية (التوصيل الهوائي باستخدام سماعة الرأس والتوصيل العظمي)، قياس ضغط الأذن، اختبار الكلام بما في ذلك عتبة استقبال الكلام ودرجات تمييز.

اختبارات المعينات السمعية واجراءات التحقق عن طريق عمل مقياس الاذن الحقيقيه واختبار عتبة الكلام واختبار تفسير الكلام وعمل استبيان لتقييم المنفعة الذاتيه النسخه العربيه من مقياس التحسن الموجه للعميل.

النتائج: ضبط المعينه السمعيه المعتمدة علي قياس الاذن الحقيقيه التلقائي أظهر نتائج افضل من ضبطها معتمدا علي الاعدادات الاوليه من قبل الشركه المصنعة من حيث نتائج السمع بالمعينه السمعيه ودرجه التعرف علي الكلام ودرجه تفسير الكلام ونتائج الاستبيان لتقييم المنفعة الذاتيه النسخه العربيه من مقياس التحسن الموجه للعميل.

الخلاصة: استخدام مقياس الاذن الحقيقيه التلقائي سوف يساعد علي استخدام جهاز الاذن الحقيقيه بشكل منتظم في عيادات ضبط المعينات السمعيه.