Original Article

Comparison of e-audiologica.pl android hearing application with pure tone audiometry for hearing assessment in normal hearing group

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Objective: To compare the accuracy of e-audiologica.pl android hearing application with pure tone audiometry in terms of hearing assessment of normal hearing group.

Methodology: This observational trial was conducted at Department of ENT, Combined Military Hospital, Kharian, over six months from January 1, to June 30, 2018. One hundred patients 18-65 year of age and of either gender with normal hearing and no ear pathology were enrolled for this study. Air conduction hearing thresholds of both ears at frequencies 250Hz, 500Hz, 1000Hz, 2000Hz, 4000Hz, and 8000Hz were measured with "cello audiometer by Inventis®" and android hearing application "e-audiologica.pl" in all patients.

Results: There were 84(84%) males and 16(16%) females among a total of 100 patients. 18 year to 65 year was age range having mean age of 30.5± 9.1 year. At frequencies 250Hz, 500Hz, 1000Hz, 2000Hz, 4000Hz, e-audiologica.pl android application gave higher readings as compared to audiometry while at 8000 Hz it gave low readings.

Conclusion: e-audiologica.pl android hearing application is an excellent tool for screening of hearing loss in areas where there is lack of standard equipment and trained staff. However, it cannot be used as a diagnostic tool. (Rawal Med J 202;45:673-676).

Keywords: e-audiologica android hearing application, pure tone audiometry, hearing threshold.

INTRODUCTION

Hearing impairment is a global health problem. In 2012, WHO estimated that roughly 360 million individuals around the globe experience the ill effects of this inability making it the most widely recognized sensory deficit in humans. The prevalence is higher in developing countries like in Sub-Saharan Africa (15.7%) and South Asia (17%).[1,2] Variety of factors are responsible for hearing loss that includes noise exposure, alcoholism, family history, smoking, hypertension, ototoxic drugs, head injury and age related hearing loss.[3] If hearing loss occurs before speech has developed it will result in delayed speech and language development which ultimately increases illiteracy rate.[4,5]

Pure tone audiometry is a gold standard test for assessment of hearing loss.[6-8] However, it requires proper sound proof booth, trained audiologist, is costly and time consuming. Moreover, it is not readily available in underserved areas.[9] With the ongoing advances in versatile innovation, numerous medical (applications) have been created. Smart phone applications are cheap, easily use readily available and easy to handle. These provide health professionals opportunities to incorporate innovations into clinical practice.[10,11] In this study, to compared the hearing levels of e-audiologica.pl android hearing application for frequencies ranging from 250Hz to 8000 Hz with pure tone audiometry in normal hearing individuals.

METHODOLOGY

After approval from institutional ethical review committee, this prospective clinical trial was conducted at department of ENT, Combined Military Hospital, Kharian from January to June, 2018. Written informed consent was sought from all patients. We included 100 patients of either gender 18-65 years of age with normal hearing in our study.

Patients having hearing loss, otitis media (acute/chronic), and history of previous ear surgery were excluded from the study.

Pure tone audiometry was performed on "cello audiometer by Inventis®"in sound proof booth for air conduction at frequencies 250, 500, 1000, 2000, 4000 and 8000 Hz by trained audiologist. Smartphone test was performed on Samsung galaxy note 4 attached to bundled head phones using e-audiologica.pl hearing app on same frequencies (250, 500, 1000, 2000, 4000 and 8000 Hz). Test was performed in a quiet room. Hearing app was downloaded from Google store free of cost

Statistical Analysis: Data were analyzed by using SPSS version 23. To test the validity, the degree of agreement between e-audiologica.pl and audiogram was calculated in terms of interclass correlation coefficient (ICC). An agreement was graded as poor for ICC values less than 0.40, fair for values between 0.41 and 0.59, good for values between 0.60 and 0.74 and excellent for values between 0.75 and 1.0. The comparison between pure tone audiogram and e-audiologica.pl was conducted through paired sample t test (ΔdB= |pure tone audiogram - e.audioloica.pl) or Wilcoxon signed rank test. Kolomogorov-smirnov test was used to test the normality of the variables. $p \leq 0.05$ was considered statistically significant.

RESULTS

There were 16(16%) female and 84(84%) male among a total of 100 patients. Age range was 18 -65 years (mean 30.5± 9.1) (Table 1). The results of validity analysis for each ear and each frequency are shown in Table 2.

Table 1. Age and gender distribution.

Age groups (years)	Male (n)	Female (n)	Total	
			n	%
18-25	27	5	32	32%
26-33	29	8	37	37%
34-41	16	2	18	18%
42-49	9	0	9	9%
50-57	1	1	2	2%
58-65	2	0	2	2%
Total	84	16	100	100%

Table 2. Reliability analysis of Pure-tone audiogram versus e-audiologia.pl with respect of ear and frequency.

Frequency (Hz)	Inter Class Correlation coefficient (95% CI)	
	Right	Left
250	0.687[b] (0.535 to 0.789)	0.675[b] (0.519-0.781)
500	0.717[b] (0.412 to 0.845)	0.612[b] (0.422 to 0.739)
1000	0.507[a] (-0.193 to 0.777)	0.563[a] (0.16 to 0.753)
2000	0.629[b] (-0.61 to 0.837)	0.716[b] (0.084 to 0.879)
4000	0.818[c] (0.729 to 0.877)	0.862[c] (0.795 to 0.907)
8000	0.871[c] (0.806 to 0.914)	0.88[c] (0.678 to 0.942)

a: Interclass correlation coefficient is fair.
b: Interclass correlation coefficient is good
c: Interclass correlation coefficient is excellent

Table 3. Comparison between Pure-tone audiogram and e-audiologia.pl with respect of ear and frequency through Wilcoxon sign rank test.

Frequency (Hz)	Side	Audiogram	e-audiologica.pl	P value
250	Right	24.7± 9.8	25.1± 6.9	0.065
	Left	23.5± 9.3	24.2± 7.5	0.416
500	Right	26.4± 8.7	28.6± 5.8	0.010
	Left	24.7± 8.7	28.9± 6.6	0.000
1000	Right	22.8± 9.1	28.5± 6.6	0.000
	Left	20.9± 8.5	29.4± 5.6	0.000
2000	Right	19.5± 9.9	25.5± 7.1	0.000
	Left	18.1± 9.6	25.8± 7.3	0.000
4000	Right	23.5± 13.6	24.9± 9.1	0.091
	Left	23.7± 14.1	25.6± 9.5	0.072
8000	Right	20.9± 15.6	15.4± 13.3	0.000
	Left	24.2± 16.1	22.05±11.3	0.045

Table 3 shows that there is significant high correlation between readings of Pure-tone audiogram and e-audiologia.pl. Comparison between pure tone audiometry and e-audiologia.pl showed that at frequencies 250Hz, 500Hz, 1000Hz, 2000Hz, 4000Hz, e-audiologica.pl android application gave higher readings as compared to audiometry while at 8000Hz it gave low readings. There was a significant statistical difference between e-audiologica.pl and pure-tone audiometry.

DISCUSSION

Smart phones have revolutionized the communications. These are pocket size computers for new generation and are essential part of our daily lives. Numerous smart phone based applications are developed for medical purposes.[12-14] These also include hearing assessment applications. Multiple

studies had evaluated these applications for use in patients.[17-25]

In our study, air conduction hearing thresholds of both ears at frequencies 250Hz, 500Hz, 1000Hz, 2000Hz, 4000Hz, and 8000Hz were measured with "cello audiometer by Inventis®" and android hearing application "e-audiologica.pl" in all patients. Results showed that there is a significant difference between readings of pure tone audiometry and e-audiologica.pl but there is a high correlation between both. Hence e-audiologica.pl android hearing application can be used for screening hearing level. Similarly, Foulad etal[15] determined the feasibility of a smart phone-based application and compared its accuracy with formal audiometry. They performed the application test in a quiet room and found 94% of the threshold values were within 10 dB of the threshold values obtained with formal audiometry in 42 subjects.

In another study, Szekely et al[16] checked the validity of U hear i-pod based application by comparing it with PTA and showed sensitivity of 98% and specificity of 82%. Mahomed et al[22] compared the validity of hear screen with conventional audiometry in 1070 school children and found sensitivity of 75% and specificity of 98.5%. Ukoumunne et al[23] compared accuracy of hear-check screen test with pure tone audiometry in 315 children and found sensitivity of 85% and specificity of 86.5% for hear check. Abu-Ghanem et al[24] compared U hear smart phone application with pure tone audiometry to evaluate the use of hearing application as a screening tool for aged people and found sensitivity of 100% and specificity of 60%.

Above mentioned studies have mostly used iPhone based applications. In our study, android based application was used. Finally, we can say that smart phone applications for hearing assessment can be used for screening purposes in remote areas where trained audiologist and conventional audiometry is not available. These applications are user friendly, cheap and readily available and can really help clinicians for hearing assessment.

CONCLUSION

e-audiologica.pl android hearing application is an excellent tool for screening of hearing loss in areas where there is lack of standard equipment and trained staff. However, it cannot be used as a diagnostic tool.

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