Original Article

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# Teleaudiology: evaluation of teleconsultation efficacy for hearing aid fitting

## *Telessaúde: avaliação da eficácia da teleconsulta na programação e adaptação de aparelho de amplificação sonora individual*

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**Keywords**

Remote consultation
Audiology
Hearing loss
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## ABSTRACT

**Purpose:** To evaluate teleconsultation's efficacy for hearing aid fitting. **Methods:** Fifty hearing impaired individuals with ages ranging from 39 to 88 years and mean audiometric thresholds between 30 and 68.75 dBHL participated in this study. Participants were divided into two groups (stratified randomization): control group (n=25), submitted to face-to-face procedures, and experimental group (n=25), submitted to synchronous teleconsultation with interactive video and remote applicative control. The hearing aids were programmed and verified (with microphone probe), and the subjects received instructions regarding use and care for the device. Time taken for the procedures was measured. Following the consultations, an evaluator (blind to the groups) applied the Hearing in Noise Test (HINT-Brazil). Approximately one month after consultations, the daily time of hearing aid use was verified, and the International Outcome Inventory for Hearing Aids (IOI-HA) was administered. **Results:** A greater time for programming and verification and a smaller time for orientation were observed for the experimental group. No difference was found between groups for the total consultation time. The real ear measures' matching to their respective targets was similar for both groups. No difference was observed between groups for the HINT results (silence and noise), the daily amount of use of hearing aids in hours, and the IOI-HA scores. **Conclusion:** Teleconsultation is an efficient procedure for hearing aid programming, verification and fitting when face-to-face services are not available.

**Descritores**

Consulta remota
Audiologia
Perda auditiva
Auxiliares de audição
Transtornos da audição
Telemedicina

## RESUMO

**Objetivo:** Avaliar a eficácia da teleconsulta para a programação, verificação e adaptação do aparelho de amplificação sonora individual (AASI). **Métodos:** Cinquenta participantes com deficiência auditiva (idades entre 39 e 88 anos), com média dos limiares audiométricos entre 30 e 68,75 dBNA, foram alocados em dois grupos (randomização estratificada), controle (n=25) e experimental (n=25), submetidos respectivamente à consulta face a face e teleconsulta síncrona com video interativo e controle remoto de aplicativos. Foram realizadas a programação e verificação do AASI (medidas com microfone sonda) e orientação dos participantes quanto ao uso e cuidados com o dispositivo. O tempo para os procedimentos foi cronometrado. Após as consultas um avaliador, cego quanto aos grupos, aplicou o teste de percepção da fala *Hearing in Noise Test* (HINT) Brasil. Aproximadamente um mês após as consultas, foi verificado o tempo diário de uso do AASI e administrado o questionário *International Outcome Inventory for Hearing Aids* (IOI-HA). **Resultados:** Maior tempo para a programação e verificação e menor tempo para orientação foi observado para o grupo experimental. Não houve diferença entre grupos no tempo total do atendimento. A equiparação das medidas com microfone sonda aos respectivos *targets* de amplificação foi similar para os dois grupos. Não houve diferença entre os grupos quanto aos resultados do HINT-Brasil (silêncio e ruído), o tempo médio de uso diário do AASI e resultados do IOI-HA. **Conclusão:** A teleconsulta é um procedimento eficaz para a programação, verificação do AASI e orientação de usuários quando serviços face a face não estiverem disponíveis.

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## INTRODUCTION

Telehealth involves the transfer of health information between distant locations through information and communication technologies and is considered an alternative for improving health care in developing countries as well as in regions of low population density or with limited access to health care services. In Brazil, there was an important evolution of telehealth, particularly in the last decade, with increased incentives for research as well as through government actions such as the "Brazil Telehealth Program", originally designed to support primary care and now expanded do encompass all levels of attention.

Teleconsultation is the application of technology to extend health services at a distance, connecting professional/client or professional/professional to provide educational services, prevention, diagnosis or intervention. This type of remote consultation can reduce direct and indirect costs of care, and facilitate access to geographically isolated populations from specialized health services. It also reduces the gap between the need and availability of professionals and services[1,2].

In Brazil, the legislation of the use of teleconsultation in Speech-Language Pathology and Audiology (SLP-A) was published in 2009 by the Federal Council of SLP-A[3]. One of the articles in this resolution provides that the procedures performed via teleconsultation must ensure the same efficacy of those made face to face.

The remote control of computers and their peripherals, associated with interactive video, is an example of synchronous teleconsultation (real time), which has been used in the field of audiology. The efficacy of this type of teleconsultation was proven for hearing screening, electrophysiological assessment and cochlear implant mapping[4].

Regarding the hearing aids (HA), studies evaluated the remote programming and verified such devices in an isolated format[5,6]. However, it is necessary to obtain more information regarding the outcomes of teleconsultation for: HA programming, verification and fitting; and the provision of informational counseling to patients, when compared to face to face consultations, which is the objective of the present study.

## METHODS

Prospective, randomized, blind study carried out in the Speech-Language Pathology and Audiology Clinic, Bauru School of Dentistry, Universidade de São Paulo and approved by the Research Ethics Committee of this Institution (CEP FOB/USP 144/2009).

### Participants

Voluntarily participated in the study, after signing a consent form, 50 hearing aid candidates (30 men and 20 women) aged 39-88 years, with bilateral symmetric sensorineural mild to severe hearing losses. Participants did not have associated disabilities and had no previous experience with HA use.

The participants were divided into two groups: experimental (n=25) and control (n=25) by using stratified randomization. The sample was separated into groups (strata) according to participant's age (adult x elderly), degree of hearing loss and HA features. It is noteworthy that for the selection of HA style and model, the audiological features and communicative needs of the participants were taken into consideration. According to this analysis, hearing aids model 1 (CIC), 2 or 3 (mini-BTE), from the same brand, were selected. All hearing aids were digital and programmable. Hearing aid models 1 and 2 had the following features (same HA family): four channel wide dynamic compression area (Wide Dynamic Range Compression – WDRC), noise reduction, expansion, feedback cancellation (phase inversion), two memories, directional dual microphone (only hearing aid 2) and datalogging. In this study datalogging was used to store the average hearing aid, use hours and, use of multiple memories. The model 3 had the same characteristics mentioned above, except that the compression consisted of six channels.

An equal number of participants from each stratum were allocated to experimental (teleconsultation) or control (standard face to face procedure) groups by a simple raffle.

Participant's demographic, educational and socioeconomic status[7] were extracted from medical records (Table 1).

### Procedures

The procedures were performed by two different evaluators and a facilitator:

- Evaluator 1 (audiology specialist with at least four years of experience in HA selection, verification and fitting): performed HA programming and verification procedures face to face and via teleconsultation.
- Evaluator 2 (audiologist with experience in speech perception in noise assessment) was blinded for the service model and applied the HINT tests and the IOI-HA questionnaire.
- Facilitator (undergraduate SLP-A student or SLP-A professional without experience in hearing aid fitting): assisted the evaluator 1 during teleconsultation procedures.

Hearing aids were programmed via HiPro and NOAH

**Table 1.** Demographic data of the participants of the experimental (n=25) and control (n=25) groups

| Group | Hearing aid | | | Gender | | Education | | | | | | Socioeconomic classification | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | M | F | Illiterate | JHI | JH | HSI | HS | U | LI | LS | AI | A |
| Control | 7 | 11 | 7 | 17 | 8 | 3 | 17 | 3 | 1 | 0 | 1 | 4 | 19 | 2 | 0 |
| Experimental | 7 | 11 | 7 | 13 | 12 | 2 | 15 | 4 | 0 | 2 | 2 | 6 | 18 | 1 | 0 |
| Total | 14 | 22 | 14 | 50 | 50 | 50 | | | | | | 50 | | | |

**Note:** F = female; M = male; JHI = junior high incomplete; JHI = junior high; HIS = high school incomplete; HIS = high school; U = undergraduation; LS = low superior; LI = low inferior; AI = average inferior; A = average

platform connected to a desktop computer. In all cases, the prescriptive rule NAL-NL1[8] was used for HA programming and the software's adaptation manager was positioned at the maximum. The datalogging feature was always enabled for further analysis of the average number of hours of daily use of the hearing aids.

The probe microphone measurements were performed with the Unity equipment (Siemens®) using unmodulated speech noise. For all the participants, noise reduction and feedback cancelation features were disabled during the verification procedure, so they will not interfere as to the type of stimulus presented, and were then reactivated. It was obtained the real ear unaided response (REUR), real ear aided response (REAR) and the real ear insertion gain (REIG). The REUR was obtained for 65 dBSPL input and the REAR and REIG were recorded for inputs of 50, 65 and 80 dBSPL, respectively.

Since the participants did not present alterations in the external and/or middle ear and since all of them presented typical external ear resonance responses, only the REIGs were analyzed in this study. The REIG values in inter-octaves from 250 Hz to 6 kHz, for the three input levels used were compared to the targets prescribed by the NAL-NL1 rule. A good matching was considered when the difference between the target and REIG did not exceed 5 dB[9].

It should be noted that when REIG curves did not match NAL-NL1 targets, hearing aids were manually fine tuned to achieve the prescribed amplification goals. The need for such adjustments is expected since the software simulations tend to overestimate the amplification provided in the real ear, especially at high frequencies[10].

After this fine tuning, in case the participant presented loudness or sound quality complaints, the evaluator 1 provided informational counseling regarding the need for audibility (REAR responses were also taken into consideration) and the adaptation to the amplified sound. Only when the participant's complaint persisted despite the provision of counseling, hearing aid amplification adjustments were modified, reducing amplification in order to provide acoustic comfort. In such cases, both the participant and the evaluator were aware that the device did not provide audibility deemed necessary by the NAL-NL1 rule.

After the verification process, informational counseling was carried out in order to instruct participants regarding hearing aid use, care and handling. The following topics were discussed: cleaning and care of the hearing aids and/or earmolds; HA battery insertion and removal; battery duration, HA/earmold insertion and removal; manipulation toggle switches and/or memory button. Counseling was also provided as to the HA use expectations, effects of hearing loss and use of strategies to optimize communication.

For the experimental group, the procedures were performed via synchronous teleconsultation. The facilitator remained with the participant in the SLP-A Clinic, in the same room used for the face to face consultations, here in after the "test environment". In this room there was a desktop computer connected to the internet (local area network – LAN USP) and coupled to the HI-Pro interface and Unity PC Probe Mic equipment. For the video and audio communication the Logitech® QuickCam Orbit webcam with built-in microphone was used. A pair of speakers was also connected to the computer. The evaluator 1 was positioned in the "remote environment", located in another building 300 meters away from the "test environment". This evaluator used a personal computer with a Pentium IV with 2 Gb and 256 Mb memory and a Windows XP operating system, connected to a headset Microsoft® LifeChat LX3000, a webcam (Trust WebCam 15007) and LAN USP (Figure 1).

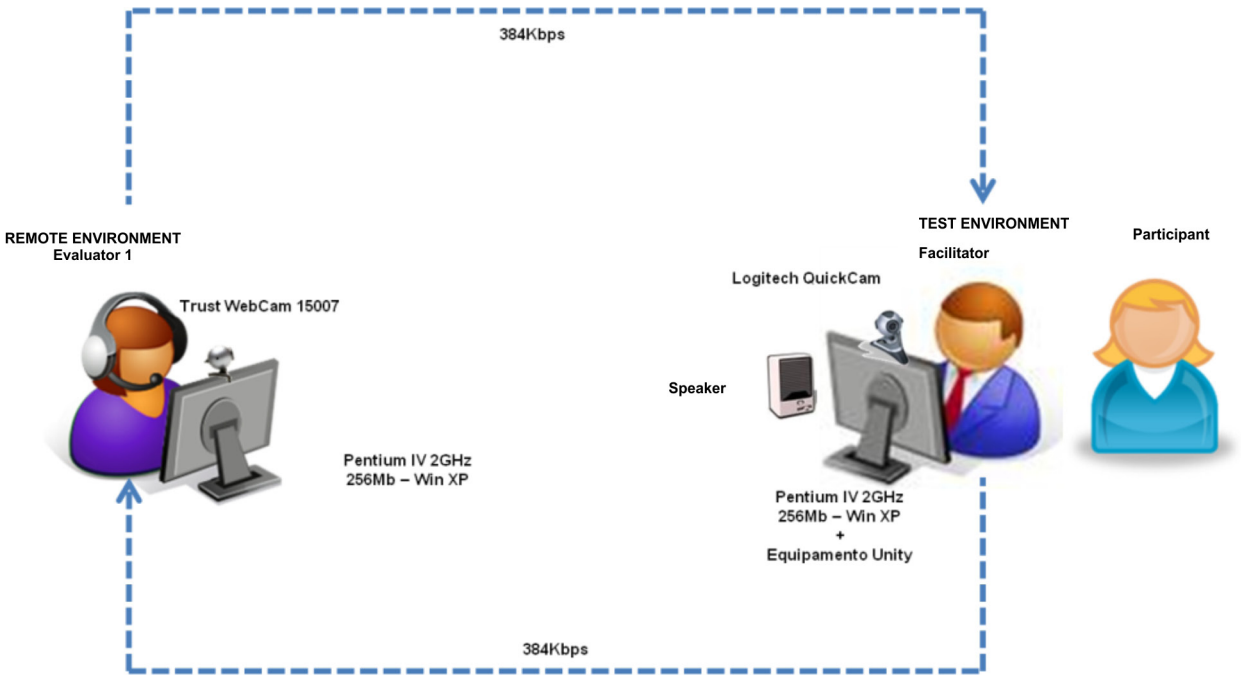


**Figure 1.** Schematic representation for conducting the teleconsultation

The Polycom PVX Version 8.0.2 application (Voice Video Data Web) was installed on the computers of both test and remote environments and was used for data sharing as well as audio and video streaming (connection speed of 384 kbps). With interactive audio and video, evaluator 1 could provide instructions for the facilitator and the participant in real time. Under the evaluator's instruction the facilitator performed the following procedures: otologic inspection, connecting the hearing aids to the programming cables and the HI-Pro interface, HA/earmold insertion and removal, positioning the probe tube for calibration, positioning the participant in the test environment, insertion and removal of the probe tube in the participant's ear.

The data sharing function of the Polycom PVX software allowed the evaluator 1 to remotely control the software for HA programming and verification installed on the computer of the test environment, then performing procedures for the programming and verification of the hearing aids and providing counseling for the participant, following the same protocol as described for the control group. Because the evaluator 1 could view, in real time, the programming software and verification equipment screens, while simultaneously interacting with the participant and facilitator via audio and video, she could intervene whenever necessary.

During informational counseling, the evaluator first demonstrated in front of her webcam how to handle the hearing aid mold and asked the participant to perform the same activity, monitoring whether this was appropriate. When difficulties were perceived, the instructions were repeated. If the participant could not perform the task correctly, with evaluator's guidance, the facilitator was asked to assist the participant.

The face-to-face and teleconsultations procedures for hearing aid programming, verification and participant's orientation were timed.

For both groups, immediately after the orientation, the evaluator 2 performed the speech perception evaluation, using the adaptive procedure of the Hearing in Noise Test (HINT) in Brazilian Portuguese[11]. A single speaker was used, positioned at a distance of one meter from the participant, at 0° azimuth and at height of the HA microphone, for silence and noise assessments. In both cases, a list of 20 sentences randomly chosen by the HINT PRO software was presented. The score for the test in silence was the recognition of 50% of the sentences presented, being expressed in dB(A). The test scores in noise, expressed in dB S/N, represents the signal to noise ratio threshold in which the sentences were recognized. Thus, lower signal-to-noise ratio indicates a better performance of the participant in this condition.

After a minimum period of one month`s use of the hearing aids, the participants returned to the clinic, where face to face evaluations were conducted for both groups. First of all, hearing aid daily use hours were collected from the datalogging by the evaluator 2. When the datalogging record indicated "zero", the evaluation was not carried out. In this case, the participant was asked by the evaluator 2 as to the reasons for not using the hearing aids and, if needed, adjustments were made in the hearing aid settings and/or information regarding hearing aid use and handling was revised – then a new appointment for the evaluation was made.

In other cases, the International Outcome Inventory for Hearing Aids (IOI-HA)[12] was administered. The IOI-HA is composed of seven questions, each with five response options, equivalent to values 1-5, arranged gradually, from left to right, so the first option indicates the worst performance (value 1) and the last option indicates a better performance (value 5)[13].

The inventory was administered in pencil and paper format. The participants were instructed to answer it anonymously. They were asked to read each question and mark the answer that most resembled their judgment. In the case of illiterate participants, the evaluator 2 read the questions and answers and the participant chose the appropriate response. Soon after, the evaluator 2 scored the questionnaire and handed it to evaluator 1, who had control over the scheduling of the participants and therefore, could identify whether the individual belonged to the experimental or control group.

The IOI-HA was scored manually. The results can be analyzed by each item individually, or by the sum of all items. The higher the score, the better the outcome provided by the hearing aid[13].

The statistical analysis was performed using the Student's t test for comparisons between the experimental and control groups regarding the time taken for the procedures, daily use of the hearing aids and the difference between the measured insertion gain (REIG) and the target. The Spearman correlation coefficient test was used to assess the relationship between the duration of daily use of the hearing aids indicated by the participant and the time recorded in the datalogging device. In all cases, the significance level was equal to 5%.

## RESULTS

The time spent for hearing aid programming, probe microphone measures, informational counseling and the overall consultation time for the experimental and control groups were computed (Table 2).

For 18 participants during teleconsultations some technical problems were found, related to the connection and audio and video transmission. However, these problems were readily resolved.

The means and standard deviations of the differences between NAL-NL1 targets and the REIG obtained for intensities of 50, 65 and 80 dB SPL, at frequencies of 250 to 6 kHz for 50 ears from the control group and 50 ears from the experimental group were calculated (Table 3).

The results of the speech recognition in quiet and in noise are shown in Table 4. Three participants in the experimental group failed to perform the evaluation of speech perception in quiet and in noise. One participant in the control group failed to perform the procedure in the noise situation.

Four participants in the control group and three in the experimental group missed the return for the follow-up, even after other contacts and scheduling efforts were made. With regard to the datalogging information, for a participant in the experimental group, 24 hours of daily use of hearing aids for

**Table 2.** Comparison of the time taken to carry out the procedures for the control (n=25) and experimental (n=25) groups

| | Time to carry out the procedures (in minutes) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Programming | | Verification | | Counseling | | Total | |
| | C | E | C | E | C | E | C | E |
| Mínimum | 10 | 14 | 6 | 9 | 23 | 20 | 54 | 63 |
| Maximum | 23 | 28 | 15 | 27 | 49 | 46 | 102 | 109 |
| Mean±SD | 17.1±4.3 | 20.6±3.7 | 10.4±2.0 | 14.2±4.1 | 36.9±.9 | 30.0±7.4 | 82.2±14 | 81.3±12 |
| p-value | 0.003* | | 0.000* | | 0.004* | | 0.823 | |

* Significant values (p≤0.05) – Student t test
**Note:** C = control; E = experimental; SD = standard deviation

**Table 3.** Differences between the target and the REIG between the experimental (n=50 ears) and the control (n=50 ears) groups

| Intensity (dBSPL) | | Frequency (Hz) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 250 | 500 | 1k | 2k | 3k | 4k | 6k |
| 50 | C | 2.12±2.5 | 3.02±2.6 | 4.86±2.8 | 5.00±3.6 | 4.28±3.8 | 3.70±2.6 | 5.46±3.2 |
| | E | 2.58±3.0 | 3.46±2.9 | 5.40±.6 | 4.60±3.1 | 4.44±3.1 | 4.22±3.2 | 5.44±3.5 |
| | p-value | 0.41 | 0.43 | 0.32 | 0.55 | 0.81 | 0.37 | 0.98 |
| 65 | C | 2.72±2.7 | 3.24±3.1 | 3.98±3.4 | 3.16±3.4 | 2.50±3.3 | 2.08±2.4 | 7.18±4.4 |
| | E | 1.94±2.3 | 2.10±2.4 | 4.98±3.3 | 5.30±4.1 | 3.34±2.8 | 3.24±3.1 | 8.42±4.2 |
| | p-value | 0.13 | 0.04* | 0.14 | 0.00* | 0.18 | 0.04* | 0.15 |
| 80 | C | 1.16±1.6 | 1.44±1.7 | 2.14±2.2 | 2.44±2.7 | 2.00±2.0 | 2.38±2.1 | 10.82±4.0 |
| | E | 1.94±1.8 | 1.48±1.5 | 3.58±2.6 | 2.82±2.7 | 1.52±1.7 | 3.30±2.9 | 10.14±4.3 |
| | p-value | 0.02* | 0.90 | 0.00* | 0.49 | 0.19 | 0.07 | 0.41 |

* Significant values (p≤0.05) – Student t test
**Note:** C = control; E = experimental; SD = standard deviation; REIG = real ear insertion gain

**Table 4.** Comparison of the performance in the Hearing in Noise Test between the control (n=25) and experimental (n=25) groups

| | Speech Reception Threshold | | Signal to noise ration | |
|---|---|---|---|---|
| | Control | Experimental | Control | Experimental |
| Mean±SD | 56.24±8.17 | 51.78±7.24 | 4.94±3.16 | 4.17±4.15 |
| p-value | 0.055 | | 0.490 | |

* Student t test (p≤0.05)
**Note:** SD = standard deviation

**Table 5.** Datalogging recordings for the experimental and control groups

| | Daily hours of hearing aid use | | | | Number of days of use hearing aid use | |
|---|---|---|---|---|---|---|
| | Right ear | | Left ear | | | |
| | C | E | C | E | C | E |
| Minimum | 0 | 0 | 0 | 0 | 15 | 25 |
| Maximum | 14 | 24 | 13 | 24 | 128 | 53 |
| Mean±SD | 6.9±4.5 | 5.4±4.9 | 6.2±4.4 | 6.1±5.0 | 36.0±22.0 | 34.0±6.0 |
| p-value | 0.31 | | 0.92 | | 0.69 | |

Student t test (p≤0.05)
**Note:** C = control; E = experimental; SD = standard deviation

both ears were recorded, because the individual had forgotten to turn off the device. For this reason, this data was excluded from the analysis. Thus, the datalogging analysis was performed for 21 participants from the control group and 21 from the experimental group (Table 5).

For two participants of the control group and three from the experimental group the datalogging record indicated "zero hours" of hearing aids use, thus the IOI-HA was not administered to them.

The correlation (Spearman) between the results of the first

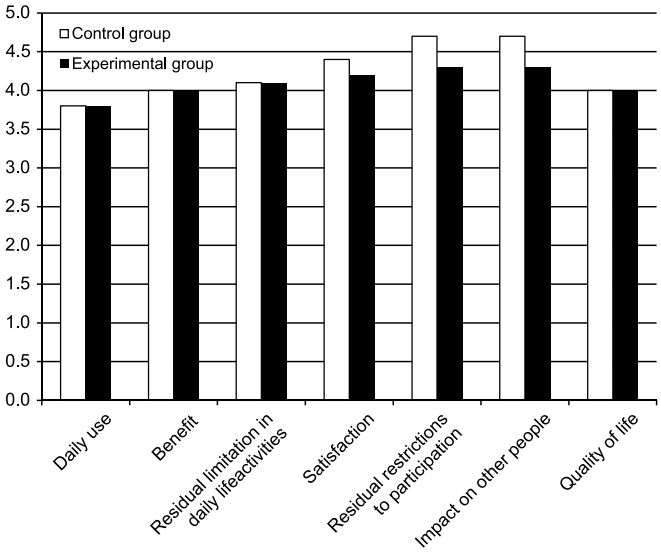


**Figure 2.** Mean IOI-HA scores for the control (n=19) and experimental (n=19) groups.

question of the IOI-HA (which refers to the number of hours of daily use of the hearing aids) and the daily use time recorded in the datalloging was verified. Strong and significantly positive correlations were obtained for the control (r=0.74, p=0.00) and the experimental groups (r=0.81, p=0.00).

Nine participants from the control group and 11 from the experimental group had some kind of difficulty while using the hearing aids that led, among other consequences, to a reduction in the daily use of the devices. These difficulties involved the need for adjustments in hearing aids or earmold, the provision of informational or personal adjustment counseling or even formal auditory training.

## DISCUSSION

The average overall time of consultations was similar for the control and the experimental groups, indicating no influence of the service model used (Table 2). Although, times for the programming and verification of the hearing aids via teleconsultation were significantly higher than for the procedures performed face-to-face, such differences are irrelevant from a clinical standpoint.

Time differences between procedures performed face to face and via teleconsultation were also found in studies that assessed pure tone audiometry[14] and cochlear implant programming[15].

Different factors may have contributed to the increased length of hearing aid programming and verification via teleconsultation. A major factor involved the necessity of the evaluator to instruct the facilitator about the steps of the procedures performed. The difficulties of a professional to follow the guidance of an expert for remote cochlear implant programming also increased the time spent in these sessions. Thus, the prior training of the facilitator can optimize synchronous teleconsultation[16].

Other factors that contributed to the increased duration of teleconsultation were some technical difficulties, mainly related to the maintenance and quality of the video. For example, during the attending of seven participants from the experimental group, evaluator 1 video's was not showing any image, however, the image was restored after restarting the Polycom PVX software. Studies have also reported minor technical difficulties during the recording of auditory evoked potentials (AEP) at a distance, which are mainly related to the available bandwidth and internet traffic for audio and video streaming along with data from the AEP[17].

It is noteworthy that the time spent with the procedures should be considered in the context of where there is demand for teleconsultation, i.e. areas where access to specialized services is difficult or nonexistent, then being required to spend much more time and resources with displacements of the patient or practitioner. In Brazil, cochlear implant users reported that although the device programming via teleconsultation was a little longer than via face to face, this was offset by time and costs savings from not travelling to specialized centers[16].

With regards to informational counseling, time spent in teleconsultation was significantly shorter than time spent in face to face procedures (Table 2). During the teleconsultation, participants were very active, striving to accomplish the tasks of hearing aid and/or ear mold handling demonstrated via videoconference, rather than passively observe them. When encountering difficulties to perform some tasks, participants first requested assistance from the facilitator and later sought to interact with the evaluator from a far.

It was also observed that the informational counseling sessions via teleconsultation were more structured and focused on the usage, handling and care of the hearing aids as well as the possible difficulties resulting from this process, "icebreaker" conservations were not frequent between the evaluator and the participant. This factor may have contributed to the decrease in time for informational counseling procedures[18].

Participants from both groups exhibited some difficulties regarding the use, care and handling of the devices, thus it can be concluded that the informational counseling conducted at a distance and aided by a facilitator had no negative effect on those skills. Also, counseling via teleconsultation had no impact on hearing aid usage (Table 2).

It is worth remembering that however good the audio quality of a videoconference, changes in the intensity and spectrum of the interlocutors' original speech will occur, because it is derived through the speaker[15], which in turn can hinder communication with the hearing impaired. For this reason, it is important that the quality of the video signal transmission also be assured enabling the use of visual cues. Other communication strategies must be employed such as reduced speech rate, the use of clear articulation, the use of circumstantial cues, the manipulation of the physical environment and the reduction of background noise[19].

For both groups, the higher values of differences between the target and REIG were recorded in high frequencies, for all input levels. This result can be explained by the frequency response of the hearing aids used in this study, demonstrating a decrease of amplification for frequencies above 5 kHz (Table 3).

Another aspect that should be considered is that the recording of the gain of high frequencies suffer a greater influence of the probe tube placement, due to the presence of standing

waves in the ear canal and the turbulence generated in the region of the earmold opening. High frequency responses are also influenced by the individual's head movements during the measurements[9].

Table 3 also shows that the differences between the control and experimental groups were small, but significant, for the input level of 65 dB SPL at frequencies of 500 Hz, 2 and 4 kHz. There was also a significant difference between the groups for the 80 dBSPL input at frequencies of 250 Hz and 1 kHz. In these cases, negative values indicated that the experimental group was more distanced to the target. It should be noted, however, that the magnitude of such differences between groups is clinically negligible because it is smaller than the REIG's own test-retest variability[20].

Regarding the speech perception assessment, the speech recognition threshold in quiet (SRT) for the experimental group was lower than for the control group (Table 4). With regards to the performance in noise, the signal/noise ratio for speech recognition in the experimental group was also lower than for the control group. In both assessments there was no difference between the groups. A study with cochlear implants users also found no significant differences for speech perception outcomes and free field audiometry thresholds between groups of users undergoing remote mapping and conventional mapping[15].

It must be emphasized that three participants in the experimental group failed to perform the evaluation of speech perception in quiet and in noise, despite the various attempts made by the evaluator. Thus, the values of the SRT and the S/N ratio of these participants were not included in calculating the average, which may have contributed to the results of the experimental group being more favorable (lower values).

There was no difference between the groups with respect to the average daily hours of hearing aid use (Table 5), for right and left ears. The daily hours of device use is related to the adaptation to the amplified sound[21] and to hearing difficulties that individuals face in their day to day[22,23].

In this study, the participants who used the hearing aids a few hours per day had complaints involving the need for earmold adjustment due to the physical discomfort; hearing aid adjustments, mainly due to loudness complaints, and informational and personal adjustment counseling or even formal auditory training.

The average scores obtained on the IOI-HA (Figure 2) were similar to those found in the evaluations of the psychometric properties of this inventory for American English[12] or Brazilian Portuguese[24].

For both groups, the lowest scores were obtained for the first item of the questionnaire (daily use of hearing aids). The strong positive correlations between the results of this first item and the datalogging record showed that the subjective report of the participants agreed with the objective data recorded on the devices.

The first item of the IOI-HA questionnaire is not related to the other items, being more decisive to verify if the user recognizes the need to use amplification than to indicate the degree of satisfaction with the device[25].

There was no difference between the experimental and control groups, both for the total score and individual item scores of the IOI-HA.

Satisfaction is a complex concept related to different factors including lifestyle, past experiences, future expectations and the values of both the individual and society. Particularly regarding the use of hearing aids, satisfaction is also related to the importance that the individual attaches to the physical, social, psychological and financial changes that occur in the hearing aid fitting process[13].

The experience with their received audiology service also impacts the hearing aid satisfaction. Individuals who reported being satisfied with the service also tend to report greater satisfaction with the devices[22]. Although the difference between the experimental and control groups regarding satisfaction was small and not significant, it is suggested to conduct further studies to assess the patients' perspectives of the care received via teleconsultation, since there is a scarcity of such literature in the field of audiology[26].

## CONCLUSION

Teleconsultation is an effective service model to perform hearing aid programming and verification and to provide informational counseling, and may be used in situations where there is difficulty or an impediment for face to face procedures. Other studies that verify the professional-patient interaction and patient satisfaction with audiology teleconsultation are suggested.

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