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Ototoxic Effects Induced by Doxorubicin, Cyclophosphamide, and Paclitaxel in Oncological Breast Cancer Treatment Protocols

Efeitos Ototóxicos Induzidos por Doxorrubicina, Ciclofosfamida e Paclitaxel em Protocolos de Tratamento Oncológico

Efectos Ototóxicos Inducidos por Doxorrubicina, Ciclofosfamida y Paclitaxel en Protocolos de Tratamiento Oncológico del Cáncer de Mama

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Abstract

Introduction: Ototoxicity is a common complication associated with chemotherapy for breast cancer, with potential to impair auditory function and negatively affect patients' quality of life. Distortion product otoacoustic emissions (DPOAE) represent a sensitive and objective method for the early detection of alterations in outer hair cell activity, even in the absence of audiometric changes. **Objective:** To investigate the effects of the AC-T protocol (doxorubicin, cyclophosphamide, and paclitaxel) on the function of outer hair cells in the cochlea of patients with breast cancer. **Method:** A prospective, analytical, and observational cohort study. Meatoscopy and DPOAE recordings were performed at two time points: one week after the first day of the chemotherapy cycle and at the end of treatment. Statistical analysis was conducted using SPSS software version 20.0, with a significance level of 5% ($p \leq 0.05$). **Results:** The sample consisted of women with a mean age of 52.36 years (±4.78). After treatment, 78.6% reported

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PFO: study conception; critical revision; supervision.
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difficulty understanding speech in noisy environments, and 35.7% reported tinnitus. DPOAE showed a statistically significant reduction in response amplitude specifically at the 5 kHz frequency, indicating functional impairment of the outer hair cells. **Conclusion:** The AC-T protocol demonstrated ototoxic potential, with functional impairment of cochlear outer hair cells, particularly at 5 kHz. The presence of tinnitus and the high prevalence of speech-in-noise comprehension difficulties highlight the need for audiological monitoring in patients undergoing chemotherapy. The implementation of systematic auditory monitoring programs may enable early detection of hearing changes and support timely interventions.

Keywords: Chemotherapy; Ototoxicity; Hearing loss.

Resumo

Introdução: A ototoxicidade é uma complicação frequente no tratamento quimioterápico do câncer de mama, pode afetar a função auditiva e a qualidade de vida. As emissões otoacústicas evocadas-produto de distorção (EOAPD) representam um método sensível e objetivo para identificar precocemente alterações nas células ciliadas externas, mesmo sem comprometimento audiométrico. **Objetivo:** Investigar os efeitos do protocolo AC-T (doxorrubicina, ciclofosfamida e paclitaxel) no funcionamento das células ciliadas externas da cóclea em pacientes com câncer de mama. **Método:** Estudo de coorte prospectivo, analítico e observacional. Foi realizado meatoscopia e registro das EOAPD em dois momentos: uma semana após o primeiro dia do ciclo quimioterápico e ao término do tratamento. Para estatística foi utilizado o software SPSS, 20.0 e foi adotado o nível de significância de 5% ($p \leq 0,05$). **Resultados:** A amostra foi composta por mulheres com média de 52,36 anos (±4,78). Após o tratamento, 78,6% relataram dificuldade para compreensão da fala em ambientes ruidosos e 35,7% referiram zumbido. As EOAPD revelaram redução estatisticamente significativa na amplitude especificamente da frequência de 5 kHz, indicando comprometimento funcional das células ciliadas externas. **Conclusão:** O protocolo AC-T evidenciou potencial ototóxico, com prejuízo funcional das células ciliadas externas da cóclea, particularmente na frequência de 5 kHz. A ocorrência de zumbido e a elevada prevalência de queixas relacionadas à dificuldade de compreensão da fala em ambientes ruidosos reforçam a importância da vigilância audiológica nos pacientes em tratamento. A adoção de programas sistemáticos de monitoramento auditivo pode viabilizar a identificação precoce de alterações auditivas e subsidiar intervenções oportunas.

Palavras-chave: Quimioterapia; Ototoxicidade; Perda auditiva.

Resumen

Introducción: La ototoxicidad, una complicación frecuente en el tratamiento quimioterapéutico del cáncer de mama, puede afectar la función auditiva y calidad de vida. Las emisiones otoacústicas evocadas-productos de distorsión (EOAPD) constituyen método sensible y objetivo para identificar precozmente alteraciones en las células ciliadas externas, incluso en ausencia de compromiso audiométrico. **Objetivo:** Investigar los efectos del protocolo AC-T (doxorrubicina, ciclofosfamida y paclitaxel) sobre funcionamiento de las células ciliadas externas de la cóclea en pacientes con cáncer de mama. **Método:** Estudio de cohorte prospectivo, analítico y observacional. Se realizaron meatoscopía y registros de las EOAPD en dos momentos: una semana después del primer día del ciclo de quimioterapia y al finalizar el tratamiento. El análisis estadístico se utilizó software SPSS, 20.0, adoptándose un nivel de significancia del 5%. **Resultados:** La muestra estuvo compuesta por mujeres con una edad media de 52,36 años (±4,78). Después del tratamiento, el 78,6% informó dificultad para comprender el habla en ambientes ruidosos y el 35,7% acúfenos. Las EOAPD revelaron reducción estadísticamente significativa en la amplitud de respuesta específicamente en la frecuencia de 5 kHz, compromiso funcional de las células ciliadas externas. **Conclusión:** El protocolo AC-T mostró potencial ototóxico, con deterioro funcional de las células ciliadas externas, particularmente 5 kHz. La presencia de acúfenos y alta prevalencia de quejas relacionadas con la dificultad para comprender el habla en ambientes ruidosos refuerzan la vigilancia audiológica en pacientes en tratamiento. La implementación de programas sistemáticos de monitoreo auditivo puede permitir la detección temprana de alteraciones auditivas y respaldar intervenciones oportunas.

Palabras clave: Quimioterapia; Ototoxicidad; Pérdida auditiva.

Introduction

In Brazil, breast cancer is the most common malignant neoplasm among women, representing a major public health concern. In the state of Sergipe, for the biennium 2023–2025, an estimated 570 new cases are expected, corresponding to a crude rate of 46.42 cases per 100,000 women[1]. Although there are reference oncology hospitals in the Northeast region, a considerable proportion of patients face logistical and socioeconomic barriers to initiating and maintaining treatment, often requiring travel to specialised centres located in distant areas. Such limited access compromises the effectiveness of oncological treatments and highlights the urgent need for investments in hospital infrastructure, as well as the expansion and decentralisation of oncology services[2].

Among the therapeutic modalities employed in breast cancer management, adjuvant chemotherapy plays a central role, particularly in biologically aggressive tumours, such as those with HER2 overexpression. Among the pharmacological regimens widely used, the combination of doxorubicin, cyclophosphamide, and paclitaxel (AC-T) stands out for its effectiveness in reducing tumour recurrence and improving survival rates[3]. Although ototoxicity has traditionally been associated with platinum-based agents[4], recent evidence suggests that other drugs, such as doxorubicin, also display ototoxic potential, with mechanisms linked to oxidative stress and hair cell damage[5].

Furthermore, clinical and experimental studies have demonstrated high-frequency hearing loss associated with the administration of anthracyclines and taxanes, even in the absence of evident clinical audiometric alterations[6,7]. In cochlear organotypic models, exposure to paclitaxel has been shown to induce caspase-dependent apoptosis, resulting in damage to outer hair cells, auditory nerve fibres, and spiral ganglion neurons[8].

Although doxorubicin, cyclophosphamide, and paclitaxel exhibit a comparatively more favourable safety profile than platinum derivatives, their potential ototoxic effects warrant attention, particularly given the impact of such adverse events on the quality of life of cancer survivors. These agents, by interfering with tumour cell DNA replication, promote significant cytotoxicity and are primarily indicated for the treatment of HER2-positive tumours, in which disease control is critical to improving survival[3,8].

Given the need to broaden knowledge regarding the adverse effects of chemotherapy in breast cancer, particularly with respect to ototoxicity, the early identification of subclinical auditory alterations becomes essential. Such identification may enable timely clinical interventions capable of minimising the resulting functional impacts. In this context, the present study aims to evaluate the influence of the AC-T chemotherapy protocol (doxorubicin, cyclophosphamide, and paclitaxel) on the functioning of cochlear outer hair cells in patients with breast cancer.

Material and Method

The present study is characterised as a prospective cohort investigation of an analytical and observational nature, involving women with breast cancer. The research protocol was approved by the Institutional Research Ethics Committee, in accordance with Resolutions 466/12 and 510/16 of the Brazilian National Health Council. All patients provided written informed consent, in compliance with the bioethical principles of autonomy, beneficence, non-maleficence, and justice. Data confidentiality was ensured through anonymisation and secure storage in electronic spreadsheets with restricted access to the research team.

Patient selection took place during a health education activity in the oncology sector of a University Hospital. On this occasion, information was provided regarding the potential ototoxic effects of chemotherapy and the importance of auditory monitoring. Patients who expressed interest received additional clarification in a private setting and were formally invited to participate in the study. Data collection was conducted between January 2023 and April 2024.

Women aged between 18 and 59 years, born and residing in Brazil, with histopathological confirmation of breast carcinoma, undergoing chemotherapy at the University Hospital with the AC-T protocol (doxorubicin, cyclophosphamide, and paclitaxel), were included. Participants were required to present baseline pure-tone audiometry within normal limits (≤ 20 dB HL)[9]; distortion product otoacoustic emissions (DPOAEs) present with amplitude ≥ 3 dB SPL and signal-to-noise ratio (SNR) ≥ 6 dB, in accordance with estab-

lished criteria in the literature[10],[11]; and absence of self-reported auditory complaints, as well as no documented auditory symptoms in their electronic medical records.

Patients were excluded if they presented: verbal communication difficulties that prevented application of the assessment instruments; diagnosed cognitive or neurological impairments; clinical restriction to bed rest that precluded audiological examinations; history of prolonged occupational exposure to intense noise or acoustic trauma; previous otological surgery; prior diagnosis of auditory disorders; presence of metabolic comorbidities, such as diabetes mellitus or arterial hypertension; and history of previous oncological treatment, irrespective of the primary tumour site.

The composition of the sample followed rigorous inclusion and exclusion criteria in order to guarantee group homogeneity and strengthen the internal validity of the findings.

The therapeutic regimen adopted for the patients followed the AC-T protocol[12], consisting of intravenous administration of doxorubicin at a dose of 60 mg/m² and cyclophosphamide at 600 mg/m², both on Day 1 of each cycle, repeated every 21 days for a total of four consecutive cycles. This was followed by intravenous paclitaxel at 175 mg/m², administered on Day 1 of each cycle, with an interval of 14 days between cycles, for an additional four cycles.

Information concerning the chemotherapy regimen, including dosage, number of cycles, and treatment modality, was extracted from patients' electronic medical records.

For inclusion in the study, participants who had formally consented were initially submitted to inspection of the external auditory canal through otoscopy, using the Pocket Junior otoscope (model 22840, Welch Allyn). In cases of obstruction of the external auditory canal, patients were referred to otorhinolaryngological evaluation to ensure clearance and enable subsequent audiological testing.

Thereafter, audiological evaluation was performed by means of conventional pure-tone audiometry using the AD 229b audiometer (Interacoustics, Denmark), duly calibrated in accordance with international standards set by ISO 8253-1 (2010). The examinations were conducted in an acoustically treated booth, in order to determine air-conduction thresholds at frequencies between 250 and 8000 Hz. When required, bone-conduction thresholds were assessed at frequencies between 500 and 4000 Hz. Hearing thresholds were defined as the lowest intensity level, expressed in decibels hearing level (dB HL), at which the patient responded to at least two of three stimulus presentations, according to the World Health Organization's criteria for normal hearing (≤ 20 dB HL)[9].

Finally, distortion product otoacoustic emissions (DPOAEs) were recorded, with valid responses defined as those exhibiting amplitude ≥ 3 dB SPL and SNR ≥ 6 dB, in line with previously established technical standards[10],[11].

Thus, after analysis of audiological examinations and verification of compliance with inclusion criteria, patients were formally enrolled in the study. Methodological procedures included the administration of an anamnesis through a structured questionnaire developed by the principal investigator, addressing identification data, sociodemographic profile, oncological clinical history, and information relating to auditory health before initiation and after completion of chemotherapy.

Data collection through DPOAEs was performed at two distinct time points during chemotherapy. The first assessment took place one week after Day 1 (D1) of the first chemotherapy cycle, while the second was conducted following administration of the final dose of the AC-T protocol. The corresponding start and completion dates of treatment were determined based on analysis of records from the medical team, as documented in patients' electronic medical files.

Assessment of outer hair cell function was performed by means of DPOAEs, using continuous pure-tone pairs (f1 and f2) with an f2/f1 ratio of 1.2, at intensities of 65 dB SPL (f1) and 55 dB SPL (f2). The OtoRead device (Interacoustics, Denmark) was employed in DPOAE mode. Cochlear responses were recorded at frequencies from 2000 to 5000 Hz, and were considered within normal limits when amplitude was ≥ 3 dB SPL and SNR ≥ 6 dB, criteria widely recognised for evaluating cochlear integrity in adults[10],[11].

The results of DPOAE assessments were recorded in patients' electronic medical files, ensuring access for the oncology care team. In addition, an individual copy of the results was provided to each participant, guaranteeing the right to information and the opportunity for shared follow-up of auditory status throughout treatment.

Statistical analysis was performed using SPSS software, version 20.0. Initially, descriptive statistics were applied for characterisation of the sample. Normality of continuous variables was assessed using the Shapiro–Wilk test (significance level $p \leq 0.05$). Continuous variables with normal distribution were compared using the Student's t-test; categorical variables were analysed using the Chi-square test. As no statistically significant differences were observed between right and left ear responses, data were pooled for analysis. Results were expressed as means and standard deviations, allowing for accurate evaluation of the impact of the AC-T protocol on cochlear outer hair cell function.

Results

Of the 89 individuals initially screened, 14 met all predefined inclusion criteria and comprised the final study cohort. The mean age of participants was 52.36 years (±4.78). The mean interval between the onset of the first oncological signs and symptoms and the first medical consultation was 16.36 months (±14.64). The sociodemographic, clinical, and audiological characteristics of the patients following completion of the AC-T protocol are presented in Table 1.

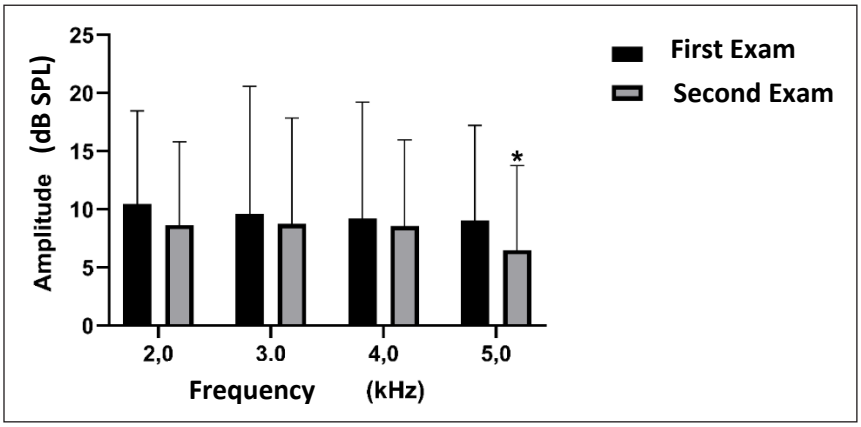
Table 1. Descriptive analysis of the sociodemographic, clinical, and auditory characteristics of the patients (n=14)

Variables	n (%)
Marital status	
Single	4(28.6)
Married	7(50.7)
Widowed	3(21.4)
Residence	
State capital	6(42.9)
Urban inland area	6(42.9)
Rural inland area	2(14.3)
Underwent surgical procedure	
Yes	8(57.1)
No	6(42.9)
Familial history of cancer	
Yes	8(57.1)
No	6(42.9)
Presence of tinnitus after chemotherapy	
Yes	5(35.7)
No	9(64.3)
Presence of dizziness after chemotherapy	
Yes	1(7.1)
No	13(92.9)
Difficulty understanding speech in noisy environments after chemotherapy	
Yes	11(78.6)
No	3(21.4)

Source: Author's data

Initially, a comparative analysis was conducted between the distortion product otoacoustic emissions (DPOAE) recorded at baseline—prior to the initiation of chemotherapy—and those obtained one week after administration of the first dose of the AC-T protocol. Statistical testing demonstrated no significant differences in response amplitudes, indicating functional preservation of the outer hair cells of the cochlea at the initial stage of chemotherapy.

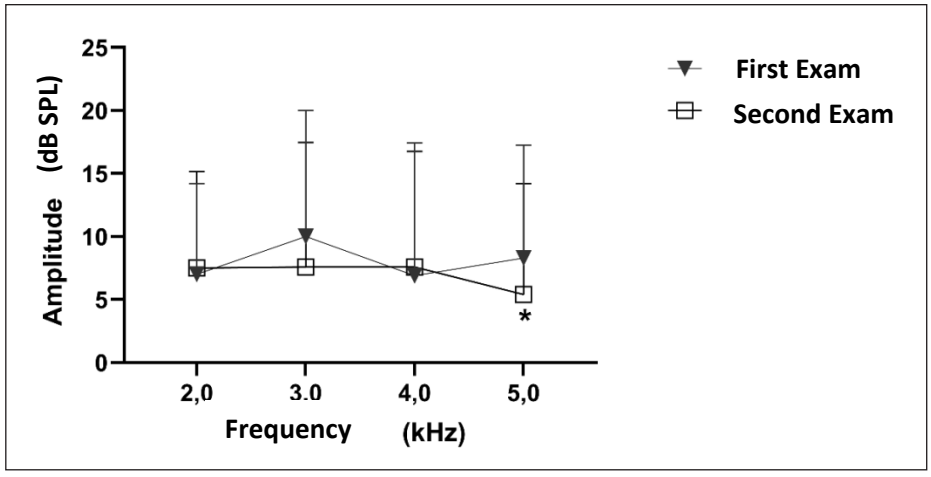
In the comparison between the first and second DPOAE assessments, absence of measurable responses was identified in 14.3% of tested ears at 2 kHz, in 17.8% at 3 kHz, in 10.7% at 4 kHz, and in 7.1% at 5 kHz. Moreover, a statistically significant reduction in cochlear response amplitude at 5 kHz was observed in the second assessment, performed at the conclusion of treatment, relative to the baseline assessment ($p < 0.05$), as demonstrated in Figure 1.



Source: Author's data
Statistical analysis: Student's t-test. Values are expressed as mean ± standard deviation (±SD). (*)p<0.05 compared with the first assessment. dBNPS: decibel sound pressure level.

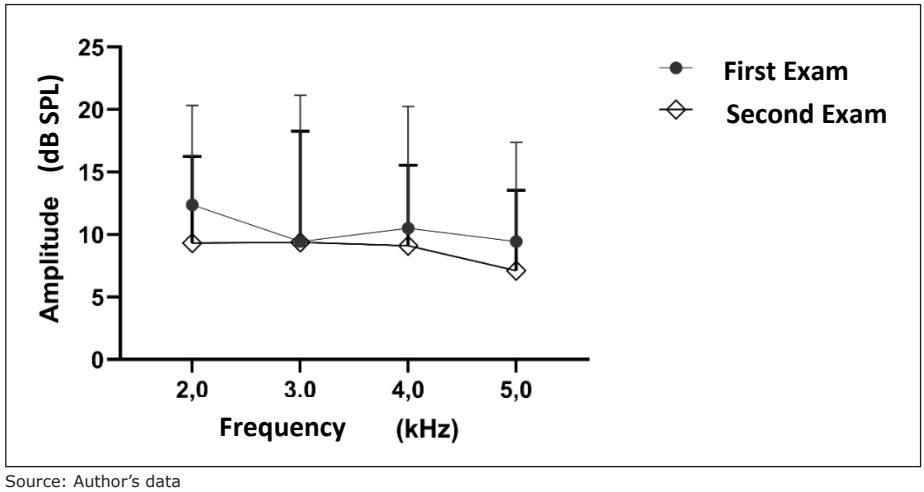
Figure 1. Effect of chemotherapy treatment, by ear, on DPOAE amplitude (n=28).

When the data were stratified according to the presence of self-reported tinnitus, bilateral occurrence was documented in five participants (35.7%). Comparative analysis revealed a statistically significant reduction in cochlear response amplitude at 5 kHz in the second assessment, performed at the end of treatment ($p < 0.05$), as illustrated in Figure 2. In contrast, among participants who did not report tinnitus, no statistically significant differences were detected in DPOAE amplitudes (Figure 3).



Source: Author's data
Statistical analysis: Student's t-test. Values are expressed as mean ± standard deviation (±SD). (*)p<0.05 compared with the first assessment. dBNPS: decibel sound pressure level.

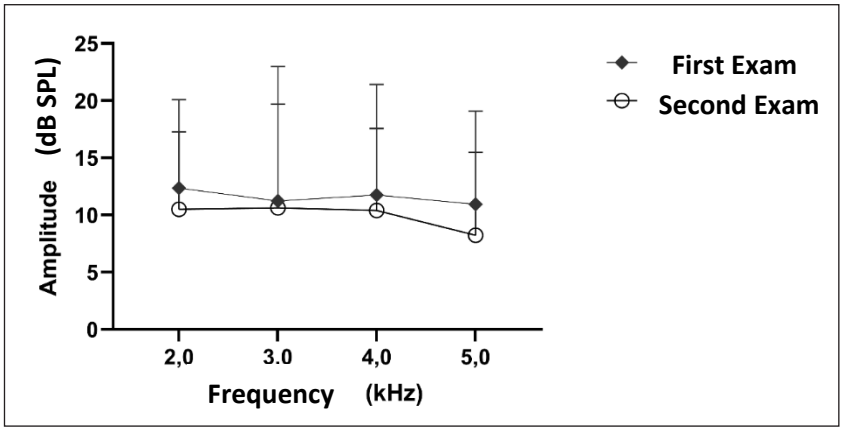
Figure 2. Effect of self-reported tinnitus, by ear, on DPOAE amplitude (n=10).



Source: Author's data
Statistical analysis: Student's t-test. Values are expressed as mean ± standard deviation (±SD). (*)p<0.05 compared with the first assessment. dBNPS: decibel sound pressure level.

Figure 3. Effect of the absence of self-reported tinnitus, by ear, on DPOAE amplitude (n=18).

The majority of participants (n = 11; 78.6%) reported bilateral difficulty in understanding speech in noisy environments, a symptom that emerged following completion of chemotherapy. Nonetheless, statistical analysis of distortion product otoacoustic emission (DPOAE) amplitudes in this subgroup did not demonstrate significant differences between pre- and post-chemotherapy assessments, as depicted in Figure 4.



Source: Author's data
Statistical analysis: Student's t-test. Values are expressed as mean ± standard deviation (±SD). (*)p<0.05 compared with the first assessment. dBNPS: decibel sound pressure level.

Figure 4. Effect of the presence of self-reported difficulty in understanding speech in noisy environments, by ear, in patients post-oncological treatment, on DPOAE amplitude (n=22).

Discussion

Breast cancer is the most prevalent malignant neoplasm among women and continues to represent a major challenge for both global and national public health systems. In Brazil, an estimated 73,000 new cases are projected between 2023 and 2025, with the highest incidence observed in the Southeast (17.2%) and Midwest (16.8%), while the Northeast and South present comparable rates (15.5%)[13]. Despite the relatively lower proportional incidence in the Northeast, persistent disparities in access to early diagnosis and specialised treatment compromise clinical outcomes and reduce survival[14]. In Sergipe, an estimated 570 new cases are expected for the 2023–2025 biennium (46.42/100,000 women), reflecting disease progression in a context of limited hospital infrastructure, particularly in remote areas[15]. These data highlight the necessity for regional studies to characterise local epidemiology, inform targeted interventions, and guide public health policies aimed at enhancing access and optimising oncological care[14].

The mean age in the present cohort (52.36 years) aligns with the expected epidemiological profile of breast cancer, whose incidence increases significantly after 50 years[1]. This finding underscores the critical importance of age-targeted screening programmes, particularly in regions such as Sergipe, where structural healthcare limitations contribute to delayed diagnosis[15]. Furthermore, 57.1% of participants reported a positive family history of breast cancer, reinforcing the need for risk-stratified screening strategies, as genetic predisposition substantially elevates disease susceptibility[16].

The mean interval between symptom onset and the initial medical consultation was 16.36 (±14.64) months, indicating a significant diagnostic delay. Such delays negatively affect prognosis and reduce the probability of effective intervention, emphasising the urgency of reinforcing both primary and secondary preventive strategies, particularly in contexts characterised by inequitable healthcare access[17].

Regarding residential distribution, 42.9% of participants lived in urban areas and 14.3% in rural settings. Although urban residency is typically associated with improved access to medical services, the present findings suggest that infrastructure deficiencies and logistical barriers may also impede access in urban areas, warranting further investigation[14].

The chemotherapeutic regimen applied in this study consisted of doxorubicin, cyclophosphamide, and paclitaxel (AC-T protocol), a standard treatment for biologically aggressive breast cancer subtypes, including HER2-positive and triple-negative tumours. HER2 overexpression is associated with rapid tumour proliferation, whereas triple-negative breast cancer, frequently linked to BRCA1 mutations, exhibits high aggressiveness and low responsiveness to conventional therapies[12]. These factors illustrate the complexity inherent in therapeutic decision-making and underscore the importance of a multidisciplinary management approach.

Within this framework, the present study demonstrated a statistically significant reduction in cochlear response amplitude at 5 kHz following AC-T administration. This decrease in DPOAE amplitude indicates functional impairment of cochlear outer hair cells, consistent with subclinical ototoxic effects. Although the observed alteration at 5 kHz is below the frequency range most commonly reported in the literature (6–12 kHz), it supports the hypothesis that chemotherapy-induced cochlear damage exhibits variable manifestation, influenced by drug type, cumulative dosage, and individual susceptibility[18].

While cisplatin is historically the chemotherapeutic agent most strongly associated with ototoxicity, accumulating evidence suggests that cyclophosphamide and doxorubicin also adversely affect cochlear structures. Mechanisms implicated include oxidative stress, mitochondrial dysfunction, and cochlear microcirculatory disturbances, culminating in injury to sensory cells and auditory neural pathways[19].

Paclitaxel, the third agent in the AC-T protocol, has similarly been associated with degenerative cochlear changes mediated by apoptosis. Experimental studies using organotypic cochlear cultures in rats demonstrated progressive degeneration of outer hair cells, auditory nerve fibres, and spiral ganglion neurons following paclitaxel exposure. These effects are primarily attributed to activation of caspase-dependent apoptotic pathways, indicating direct neurotoxicity on peripheral auditory structures[20]. These experimental findings are consistent with the subclinical cochlear alterations observed in the current study, confirming that paclitaxel may compromise cochlear integrity even in the absence of overt clinical symptoms.

Tinnitus was reported by 35.7% of participants and correlated with a significant reduction in DPOAE amplitude at 5 kHz. This finding suggests the presence of subclinical cochlear dysfunction, particularly in high-frequency regions. Literature reports that tinnitus in oncology patients treated with ototoxic agents, including cisplatin, carboplatin, doxorubicin, and paclitaxel, is frequently associated with decreased DPOAE amplitudes at higher frequencies[19,20]. Importantly, these subclinical changes often precede threshold shifts detectable by conventional audiometry, highlighting DPOAE as a sensitive and early biomarker of chemotherapy-induced auditory damage.

From a pathophysiological standpoint, these chemotherapeutic agents primarily affect cochlear outer hair cells, which are responsible for active amplification and fine auditory discrimination. Damage to these cells impairs cochlear amplification, predominantly affecting high-frequency perception and predisposing to tinnitus. Additionally, injury to auditory nerve afferents disrupts temporal coding and accurate signal transmission to the brainstem, facilitating aberrant neuronal activity and phantom sound perception[21]. Central auditory pathways also adapt to reduced cochlear input, potentially undergoing cortical reorganisation, neuronal hyperactivity, and increased synchronisation, contributing to tinnitus chronicity and severity[22]. These findings underscore the utility of tinnitus as a potential clinical marker of ototoxicity and reinforce the need for early, sensitive audiological monitoring.

Auditory complaints were prevalent: 78.6% of patients reported difficulty understanding speech in noisy environments, a hallmark of hidden hearing loss. This condition manifests despite normal conventional audiometric thresholds[23]. No statistically significant reduction in DPOAE amplitude was observed among these patients, consistent with hidden hearing loss being predominantly linked to cochlear synaptopathy rather than outer hair cell dysfunction[23,24]. Cochlear synaptopathy involves degeneration of synapses between inner hair cells

and auditory nerve fibres, frequently preceding overt sensory cell loss. Evidence suggests that chemotherapeutic agents such as cisplatin, carboplatin, paclitaxel, doxorubicin, and cyclophosphamide may induce subclinical cochlear synaptic lesions, contributing to hidden hearing loss[25].

Beyond physiological impairment, auditory dysfunction in oncology patients significantly affects emotional, social, and cognitive domains. Tinnitus and hidden hearing loss can compromise communication, limit social participation, and increase risk for anxiety and depression[26,27]. Chronic auditory effort may accelerate cognitive decline, consistent with the "cognitive load hypothesis"[28]. Collectively, these consequences impact quality of life, treatment adherence, and clinical outcomes[29], highlighting the importance of multidisciplinary care integrating audiological, psychological, and social support[30].

The lack of structured audiological monitoring during chemotherapy represents a critical gap in patient care. Regular high-frequency audiometry and otoacoustic emission testing are essential for early detection of ototoxicity and timely intervention, potentially mitigating auditory consequences and preserving quality of life.

This study presents methodological limitations. The small sample size reduces statistical power, increasing the likelihood of type II errors and limiting the detection of subtle audiological changes. Additionally, the short follow-up may underestimate cumulative or delayed ototoxic effects. These limitations restrict generalisability and emphasise the need for future studies with larger cohorts, appropriate control groups, and extended follow-up to clarify the association between AC-T chemotherapy and auditory dysfunction.

Conclusion

The findings of this study indicate that the AC-T chemotherapy protocol (doxorubicin, cyclophosphamide, and paclitaxel) exhibits ototoxic potential, with evidence of functional impairment of the outer hair cells of the cochlea, particularly at the 5 kHz frequency, as demonstrated by a statistically significant reduction in DPOAE amplitude.

Furthermore, a high prevalence of self-reported auditory symptoms was observed in the post-treatment period, with 78.6% of patients reporting difficulty understanding speech in noisy environments, suggestive of hidden hearing loss, and 35.7% reporting the presence of tinnitus.

These results underscore the necessity for systematic and early audiological monitoring in oncology patients, even in the absence of conventional audiometric alterations, to enable timely interventions and mitigate impacts on quality of life.

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