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Original Research Article

Evaluation of Tinnitus in Call Center Professionals Using Distortion Product Otoacoustic Emissions

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ABSTRACT

Occupational exposure to acoustic shock is widespread .The objective of this study was to perform an epidemiological study in order to obtain prevalence data of tinnitus following acoustic shock exposure in call center population. Auditory evaluation was performed by means of audiometer and DPOAEs in 340 call centre professionals .Out of 340 call center professionals 123 were suffering from tinnitus. So the prevalence is 37%. In these patients, tinnitus was mostly bilateral, was perceived on average at a frequency of 4 KHz and with a supraliminal intensity of 7.2 dB, and lasted on average for 7.3 years. A significant steeper slope of the audiometric curve between 2 and 3 KHz was seen. Furthermore, a notch in the distortion product-gram is noticed in 60% of the ears affected by tinnitus. This abrupt discontinuity in the activity along the tonotopic axis of the auditory system-the main characteristic of acoustic shock induced hearing loss-could be a factor eliciting tinnitus, as a correspondence between the audiometric notch and tinnitus frequency appears to exist. These findings show that tinnitus in Call center professionals is often associated with varying degrees of cochlear dysfunction.

Keyword: Tinnitus; call centre professionals; acoustic shock

INTRODUCTION

Hearing loss, as measured by pure tone audiometry, is often accompanied by tinnitus. However, tinnitus occurs without concurrent self-reported hearing loss in about 1/3rd of all cases [1] (but bear in mind that self-reported

hearing loss is poorly correlated to audiometric status). There are some reasons for this: 1) Tinnitus can be a non-auditory symptom, not involving the peripheral auditory system 2 [2]) Tinnitus can occur in conjuncture with a subclinical dysfunction of the cochlea [3, 4].

Among the several elements of occupational risk, acoustic shock is one of the agents which produce the most harmful effect on the auditory health of the individuals exposed, as it may trigger hearing alterations with varying degrees as well as non auditory problems which will reflect on their social, workplace and family behaviour [5]

Acoustic shock is one of the main causes of high pressure induced sensorineural hearing loss in India and an ever increasing number of people have been affected by acoustic trauma and gradual sensorineural hearing loss secondary to acoustic shock [6]

Call center jobs may be linked to exposure to high levels of noise, which may produce alterations in the auditory system; lack of orientation, surveillance and training for the use of individual protection equipment (IPE) and the fact that unless the levels of exposure to noise are so high that they become physically uncomfortable or produce temporary hearing threshold shifts (TTS), the short-term effects of exposure to noise will not be easily noticed [7].

Technological progress has made it possible to assess the cochlear function objectively by means of an evaluation of the Otoacoustic Emissions (OAE). This is a quick, objective and non-invasive method which may detect early cochlear alterations, first and foremost in subjects exposed to acoustic shock, unidentified by tone audiometry. The association between tinnitus and hearing loss has been well described. According to different reports, 85 to 96% of the patients with tinnitus present some level of hearing loss [8-12] and only 8 to 10% present normal audiometry [13]. The limited literature on tinnitus cases with normal audiometry is restricted to the study of otoacoustic emissions [14-16], ABR [17], auditory processing 18-20, high frequency audiometry [21] and zinc deficiency [22]. We did not find studies that approached clinical characteristics and repercussions of tinnitus in this group of patients

The paucity of studies in India about the presence of tinnitus in Call center professionals exposed to acoustic shock and considering the applicability and the preventive character in hearing monitoring by means of the OAE test, stimulated the conduction of the present study, with the purpose of studying distortion product otoacoustic emissions (DPOAE) after the exposure to acoustic shock

By emphasizing the importance of better knowing the group of subjects with tinnitus and normal audiometry, the purposes of the present study are: 1) General - to describe the sample, and 2) Specific - to check the prevalence of acoustic shock induced hearing symptoms in a young population, with special attention for acoustic shock induced tinnitus as a symptom of exposure to acoustic shock.

MATERIAL AND METHODS

In this cross-sectional study, the hearing of 340 acoustic shock-exposed call center professionals was examined. Subjects had no underlying disease (diabetes mellitus, hypertension, dyslipidemia) and were selected on the basis of the lack of exposure to ototoxic agents, ear trauma or surgery, chronic ear diseases, and a family history of hearing loss. Everyone underwent experimental testing at least 14 h after they stopped working. They had no history of upper respiratory tract infection or ear problems and were not under the influence of alcohol, so any confounding effects were avoided. Exclusion criteria were the presence of cardiovascular events, diabetes, hyperlipidemia, and immeasurable audiometric data because of poor collaboration by the participant. The inclusion criterion was exposure to a mean (SD) noise level equivalent to 85 dB (A) for 2 years

and use of the same noise-protection equipment.

The research proposal was approved by the ethical committee, Vydehi Institute of Medical Sciences and Research Center, and informed consents were obtained in all subjects.

The study consisted of two parts .First; a questionnaire was distributed to assess the prevalence of tinnitus. Later all patients underwent an exhaustive otological and audiological investigation at the ENT Department, VIMS&RC.The application of the questionnaire and the test by means of the DPOAE was performed .

Study group: we included all call center professionals who presented tinnitus in the presence of normal pure tone thresholds in all frequencies (≤ 25 dB HL in 250 to 8000 Hz).

Procedures

The subjects completed a questionnaire regarding the history of noise exposure, ear diseases, and underlying diseases. Conventional pure-tone audiometry and DPOAEs were conducted after otoscopic examination, which included the removal of wax from the ear canal.

Conventional pure-tone audiometry

The conventional pure-tone audiometry was conducted in a sound-treated room [34]. Standard audiometric procedures were applied during audiometric investigation. The hearing thresholds of each ear at frequencies of 0.25, 0.5, 1, 1.5, 2, 3, 4, 6, and 8 kHz were measured. The examined ear was defined as "normal" if a threshold shift larger than 25 dB was not found over the whole frequency range. For abnormal audiogram, threshold shifts larger than 25 dB in any audiometric range (frequency >3 kHz) of the ear were defined as "high frequency impairment."

average, the tinnitus was perceived as 7.20 ! 3.4 dB above the threshold. On average, the

The subjects underwent audiometric testing as per the above guidelines.

Later they were subjected to DPOAE testing.

DPOAE test

DPOAEs were recorded on both ears in a soundproof room by an audiologist [34]. The ILO292 Otodynamic analyzer was used. The DPOAE test consisted of presenting two primary tones at frequencies f1 and f2 at levels L1 and L2. The frequency ratio f2/f1 was fixed at 1.22. The stimuli levels were held constant at L1=65 dB sound pressure level (SPL) and L2=55 dB SPL. The level amplitude and SNR of the DPOAEs occurring at the 2f1-f2 frequency were measured with f2 frequency in half-octave-band frequencies of 1, 1.4, 2, 2.8, 4, and 6 kHz.

Amplitude of >6 dB above the level of noise floor was regarded as an indication of a distortion product (DP) being present and the subjects are assigned as a pass case.

STATISTICAL ANALYSIS

The data collected was entered in master charts and it was analyzed using statistical methods like mean, standard deviation, Mann-Whitney test, Chi-Square test, and Fisher's exact test. Level of significance reckoned as:

0.05< P < 0.10 - Suggestive of significance;

0.01< P ≤0.05 - Moderately significant;

P ≤0.01 - Strongly significant.

The data was subjected to appropriate statistical treatment.

Statistical software: The Statistical software namely SPSS 15.0, Stata 8.0, MedCalc 9.0.1 and Systat 11.0 were used for the analysis of the data and Microsoft word and Excel were used to generate graphs, tables etc.

RESULTS

Out of 200 investigated ears (tinnitotopy). In most cases, tinnitus was located at 4 KHz. On tinnitus has existed for 7.3 years, with a large spread.

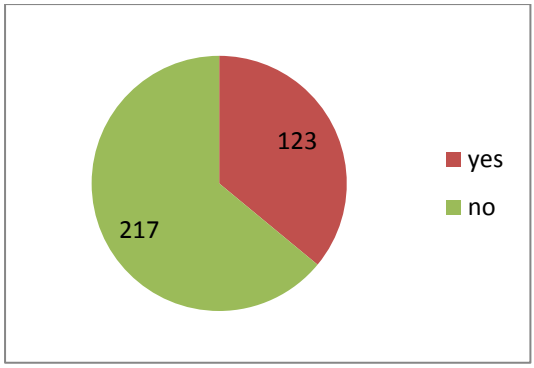

Fig 1 : Out of 340 subjects 123 subjects experienced tinnitus

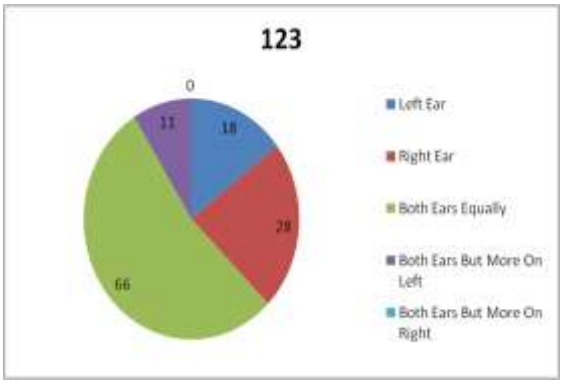

Fig 2: Localization of tinnitus in the study sample

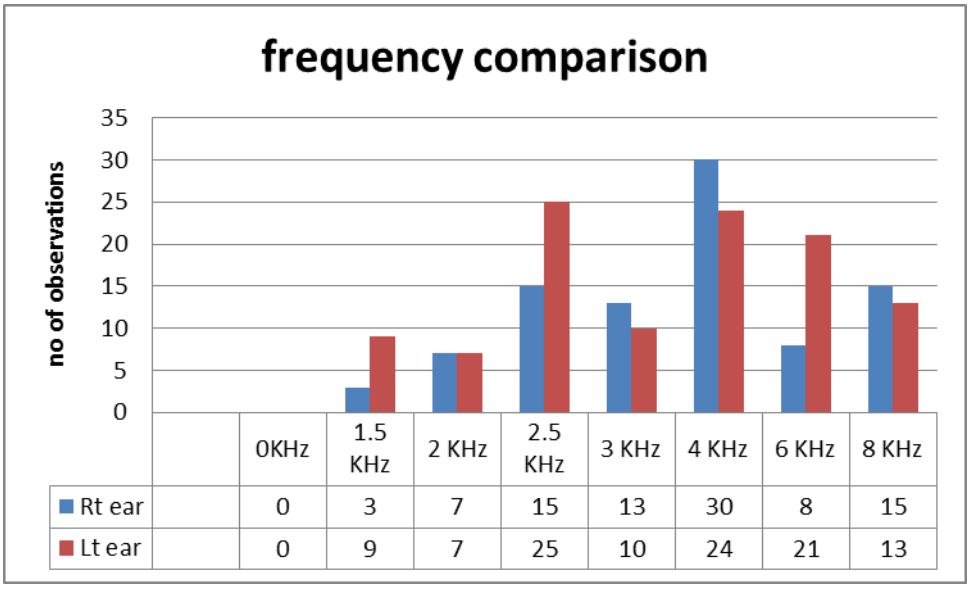

Fig 3: Distribution of perceived tinnitus frequency in the 123 subjects.

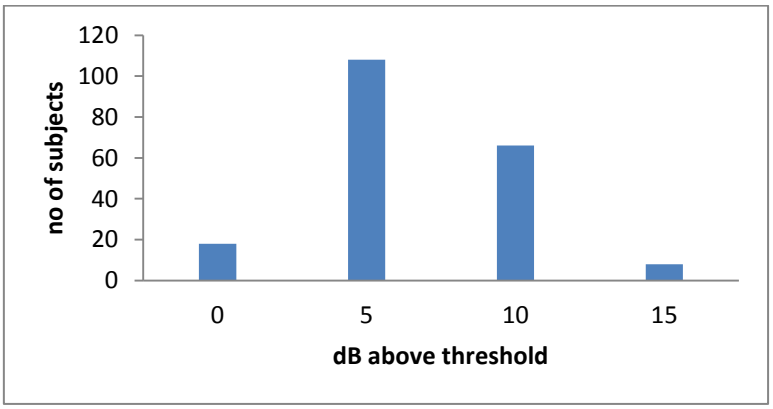

Fig 4: Distribution of perceived tinnitus intensities above the pure-tone hearing threshold

According to Attias et al [3] DPOAEs are considered to be present only if values (in decibels sound pressure level) are larger than at least two standard deviations above the upper noise floor at the corresponding frequency. We observed a notch (3-4 KHz) in the DPOAEs in

118 of the 200 ears with tinnitus ($p < .001$, Chi-square test).

DISCUSSION

Tinnitus is a symptom that may be caused by different otological, metabolic, neurological, cardiovascular, pharmacological, dental and psychological affections, which, in turn, may be present concomitantly in the same subject [6, 7]. Despite recent advances in the specific literature, the pathophysiology is still not completely elucidated, which hinders the advancement of its treatment.

Even though tinnitus is a frequently associated symptom with hearing loss detected by pure tone audiometry, it does not happen all the time. In our tinnitus research group, the prevalence of tinnitus with normal audiometry was36.2% out of a total of 340 subjects. This percentage is compatible with data by Barnea et al [13], confirming that the association with hearing loss is much more frequent.

The interpretation of tinnitus in patients with normal audiometry is quite interesting. The simple experiment by Heller and Bergman, in 1953[28], demonstrated that 94% of 80 healthy normal hearing subjects perceived tinnitus while in quiet in an anechoic chamber. Thus, it is possible that tinnitus does not always represent that something wrong is going on with the auditory pathways. In these patients specifically, the sensation of tinnitus could have represented the perception of spontaneous activity of the auditory pathway, which was facilitated by the silence of the booth. Conversely, we have seen patients whose tinnitus is the first symptom of otological diseases that are more easily diagnosed after the installation of hearing loss (otospongiosis, sound pressure level induced hearing loss, ototoxicity, vestibular schwannoma, etc.). For this reason, even if tinnitus can have the meaning shown by Heller and Bergman, we believe that hearing in these patients should be periodically monitored, in search for early signs of abnormalities.

In both groups, there was predominance of female patients, which is in agreement with the findings by McKee and Stephens [14], who found 61% of women among subjects with normal audiometry.

The presence of tinnitus frequently becomes a factor that has negative influence in the lives of subjects, hindering their sleep, concentration on daily and professional activities, as well as their social life. In many occasions it affects emotional balance of the patients, triggering or worsening anxiety and depression states [29, 30]. Disturbance caused by tinnitus and repercussions in patients' lives are certainly the determining factor for their seeking for hospitals and clinics, which justifies the high grade they scored in the analogical-visual scales with higher frequency of moderate and severe tinnitus [25]. However, our service belongs to a tertiary hospital, so we should not extrapolate these data to the general population.

The psychological aspect of tinnitus is well known and has been properly discussed by many authors [14,25,29,31]. In our study, the interference of tinnitus in the concentration and emotional status was significant Barnea et al. [13] compared subjects with tinnitus with and without hearing loss and also had similar results. Therefore, it is quite reasonable to assume that the presence of hearing loss increases the risk of tinnitus causing interference in concentration and emotional balance.

Our study to clarify the aetiopathophysiology and progression of groups of patients with tinnitus tends to support its characterization, allowing a more coherent and precise intervention in the clinical approach of these subjects.

Relation between Tinnitus and acoustic shock

Reasons to consider the relation between tinnitus and acoustic shock as improbable stem

from medical history and anamnestic data (e.g., onset of tinnitus), clinical and audiological findings, subjective characteristics of tinnitus (e.g., pulsating), tinnitometry (e.g., 125 Hz), low pitch, and data obviously pointing to acoustic shock.

Degree of Severity

For reasons of maximum objectivity in determining an impairment percentage, the estimation of the degree of severity- must rely as far as possible on factual and verifiable data. Also, purchase of devices (e.g., a tinnitus masker) for relieving tinnitus and personal expenses for alternative treatments may be relevant information.

1. The following rating scale is indicative (all items specifically concern tinnitus): Level 0 Neither medical nor alternative assistance seeking
2. Level 1 consulting the home physician; looking for alternative medicine; treatment with sedatives, hypnotics
3. Level 2 Consulting an ear, nose, and throat specialist or a neurologist; treatment with Betahistine and vasoactive drugs; physical treatments; tinnitus maskers; psychological treatments
4. Level 3 Referral to a psychiatrist; treatment with antidepressive and psychotropic drugs; psychotherapy
5. Level 4 Psychiatric hospitalization for major behavioral troubles; treatment with major psychiatric drugs

Our series included only one level-4 case, but, according to the patient himself the tinnitus was a secondary problem. Several patients consulted psychiatrist but required no more than a short treatment. In the case of a serious psychiatric problem, the medical expertise of a psychiatrist would obviously be requested

Perceived Frequency of Tinnitus (Tinnitotopy)

Our observation here is that the correspondence in frequency between an audiometric notch and tinnitus is in agreement with the literature. Okumura et al. [32] also noticed a strong correlation between tinnitus frequency and hearing loss. The presence of whistling tinnitus was found to be correlated significantly with high-frequency hearing loss [8].

Perceived Intensity of Tinnitus

The observed tinnitus sensation levels are also in agreement with values reported in the literature. Attias et al. [34] and Ozimek and Wicher [12] found in subjects with NIHL and tinnitus a notch shape of the DPOAEs that clearly reflected the hearing loss notch. Our data from the tinnitus group support these last observations. The difference with those in the control group is probably due to the more severe hearing damage at 1, 2, and 6 KHz.

CONCLUSION

This study shows tinnitus characteristics that are in full agreement with what is known from the clinical and epidemiological literature .acoustic shock related tinnitus is associated with a more specific audiometric profile of cochlear damage. this specificity mainly concerns the notch at 4 kHz and the steep slope of the audiometric curve between 2 and 3 kHz. These findings show that tinnitus in Call centre professionals is often associated with varying degrees of cochlear dysfunction. The results also suggest that tinnitus may be regarded as an early manifestation of acoustic shock-induced hearing loss in subjects with a history of exposure to acoustic shock

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CONFLICT OF INTEREST STATEMENT

None Declared

REFERENCES

1. Axelsson A, Ringdahl A. Tinnitus–a study of its prevalence and characteristics. Br J Audiol 1989; 23: 53-62.
2. Cacace AT. Expanding the biological basis of tinnitus: crossmodal origins and the role of neuroplasticity. Hear Res 2003; 175: 112-132.
3. Attias J, Bresloff I, Furman V. The influence of the efferent auditory system on otoacoustic emissions in noise induced tinnitus: clinical relevance. Acta Otolaryngol 1996; 116: 534–539.
4. Lindblad AC, Hagerman B, Rosenhall U. Noise-induced tinnitus: a comparison between four clinical groups without apparent hearing loss. Noise Health 2011; 13: 423–431.
5. Seidmann MD, Jacobson GP. Update on tinnitus. Otolaryngol Clin North Am 1996; 29: 455-465.
6. Sanchez, TG. Reabilitação do paciente com zumbido. In: Campos CA, Costa HO. Tratado de Otorrinolaringologia. São Paulo: Roca; 2002; 2: 311-324.
7. Sanchez TG. Zumbido: Análise crítica de uma experiência de pesquisa. São Paulo; 2003. (Tese de Livre-Docência, Faculdade de Medicina da Universidade de São Paulo).
8. Fowler EP. Head noises in normal and in normal and disordered ears: significance, measurement, differentiation and treatment. Arch Otolaryngol 1944; 39: 498-502.
9. Reed GF. An audiometric study of two hundred cases of subjective tinnitus. Arch Otolaryngol 1960; 71: 74-84.
10. Shea JJ, Emmett JR. The medical treatment of tinnitus. J Laryngol Otol Suppl 1981; 4: 130-138.
11. Antonelli A, Bellotto R, Grandori F. Audiologic Diagnosis of central versus eighth nerve and cochlear auditory impairment. Audiology 1987; 26: 209-226.
12. Sanchez TG, Ferrari GMS. O controle do zumbido por meio de prótese auditiva: sugestões para otimização do uso. Pró-Fono Revista de Atualização Científica 2002; 14(1): 111-118.
13. Barnea G, Attias J, Gold S, Shahar A. Tinnitus with normal hearing sensitivity: extended high-frequency audiometry and auditory-nerve brain-stem-evoked responses. Audiology 1990; 29: 36-45.
14. Mckee GJ, Stephens SD. An investigation of normally hearing subjects with tinnitus. Audiology 1992; 31(6): 313-317.
15. Castello E. Distortion products in normal hearing patients with tinnitus. Boll Soc Ital Biol Sper 1997; 73(5-6): 93-100.
16. Shiomi Y, Tsuji J, Naito Y, Fujiki N, Yamamoto, N. Characteristics of DPOAE audiogram in tinnitus patients. Hear Res 1997; 108(1-2): 83-88.
17. Favero ML, Sanchez TG, Nascimento AF, Bento RF. A Função do Trato Olivococlear Medial em Indivíduos com Zumbido. Arq Otorrinolaringol 2003; 7(4): 265-270.
18. Satar B, Kapkin O, Ozkaptan Y. Evaluation of cochlear function in patients with normal hearing and tinnitus: a distortion product otoacoustic emission study. Kulak Burun Bogaz Ihtis Derg 2003; 10(5): 177-182.
19. Sanchez TG. Zumbido: Estudo da correlação entre limiar tonal e eletrofisiológico e das respostas elétricas do tronco cerebral. São Paulo; 1997. (Tese de Doutorado, Faculdade de Medicina da Universidade de São Paulo).
20. Branco FCA. Zumbido em adultos ouvintes normais: um estudo sobre o processamento auditivo central e o handicap. São Paulo; 1998. (Dissertação de Mestrado - PUC São Paulo).
21. Nieschalk M, Hustert B, Stoll W. Auditory reaction times in patients with chronic tinnitus with normal hearing. Am J Otol 1998; 19(5): 611-8.

22.Gerken GM, Hesse PS, Wiorkowski JJ. Auditory evoked responses in control subjects and in patients with problem-tinnitus. Hear Res 2001; 157(1-2): 52-64.
23.Cai Y, Tang J, Li X. Relationship between high frequency hearing threshold and tinnitus. Lin Chuang Er Bi Yan Hou Ke Za Zhi 2004; 18(1): 8-11.
24.Ochi K, Kinoshita H, Kenmochi M, Nishino H, Ohashi T. Zinc deficiency and tinnitus. Auris Nasus Larynx 2003; 30: S25-28.
25.Sanchez TG, Bento RF, Miniti A, Câmara J. Zumbido: características e epidemiologia. Experiência do Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo. Rev Bras Otorrinolaringol 1997; 63(3): 229-235.
26.Sanchez TG, Bento RF, Santoro PP, Sasaki F, Miotto Neto B. Zumbido gerados por alterações vasculares e musculares. Arq Otorrinolaringol 2000; 4(4): 136-142.
27.Sanchez TG, Medeiros IRT, Fassolas G, Coelho FF, Constantino GTL, Bento RF. Freqüência de alterações da glicose, lipídeos e hormônios tireoidianos em pacientes com zumbido. Arq Otorrinolaringol 2001; 5(1): 16-20.
28.Heller MF, Bergman M. Tinnitus aurium in normally hearing persons. Ann Otol 1953; 62: 73-83.
29.Vallianatou NG, Christodoulou P, Nestoros JN, Helidonis E. Audiologic and psychological profile of Greek patients with tinnitus - Preliminary findings. Am J Otol 2001; 22(1): 33-37.
30.Dobie RA. Depression and tinnitus. Otolaryngol Clin North Am 2003; 36(2): 383-388.
31.Jastreboff PJ. Phantom auditory perception (Tinnitus): mechanisms of generation and perception. Neurosc Res 1990; 8: 221-254.
32.Okumura H, Satoshi S, Sato H, Takahashi S. Location of tinnitus frequency examined from the pure tone audiometric pattern. Pract Oto Rhino Laryngol 2006; 99(7):523-530.
33.Nicolas-Puel C, Akbaraly T, Lloyd R, et al. Characteristics of tinnitus in a population of 555 patients: Specificities of tinnitus induced by noise trauma. Int Tinnitus J 2006; 12:64-70.
34.Attias J, Horovitz G, El-Hatib N, Nageris B. Detection of noise-induced hearing loss by otoacoustic emissions. Noise Health 2001; 3(12):19-31.
35.Ozimek E, Wicher A. Distortion product otoacoustic emission (DPOAE) in tinnitus patients. J Acoust Soc Am 2006; 119:527-538.

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