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Original Research

Bibliometric Analysis of Publications on Stapedius Muscle

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ABSTRACT

Objective: The clinical importance of the stapedius muscle has been particularly emphasized in several publications. The purpose of this study is to bibliometrically analyze all publications on the stapedius muscle and to determine research trends related to this muscle.

Methods: The publications related to the stapedius muscle were identified by the Web of Science database. A total of 548 publications were discovered throughout the literature review. Bibliometric techniques were employed to analyze the identified publications (VOSviewer Version 1.6.13).

Results: The first studies were conducted in the 1980s. The highest number of publications related to the stapedius muscle was in 2020 (22 studies), while the lowest was in 1985 (2 studies). Most of the publications (90.11%) were written in English. The USA was the most prolific nation, with John J. Guinan having written the most articles on the stapedius muscle. Harvard University was also the most prolific institution.

Conclusion: The findings demonstrated the researchers' interest in the stapedius muscle and offered quantifiable information regarding the muscle's position within the scientific domain. Recent years have seen an increase in studies on this topic. To the best of our knowledge, it can be said that this study is the first bibliometric analysis on the stapedius muscle.

Keywords: Stapedius muscle, stapedius, bibliometric analysis, Vosviewer

INTRODUCTION

The stapedius muscle is known as the smallest skeletal muscle in the body and functions to modulate sound waves as an intratympanic muscle. The muscle is formed by fibers from the posterior belly of the digastric muscle, which pass through the stylomastoid foramen and extend to the neck of the stapes bone [1,2]. It contracts in reflex synchronization with the tensor tympani muscle. Its function is to prevent excessive movement of the stapes and reduce the amplitude of sound [3, 4]. The stapedius muscle is innervated by the facial nerve, and paralysis of the stapedius muscle may cause hyperacusis, a condition in which patients perceive normal sounds as abnormally loud [5, 6]. Regarding its relationship with the facial nerve, there are many studies on the imaging of the stapedius muscle and its relationship with the facial nerve [7]. It appears that auditory functions, auditory reflexes, hearing, and cochlear implants

are the main topics related to the muscle [8, 9]. The clinical importance of the muscle has been particularly emphasized in several publications in recent years.

A bibliometric viewpoint looks at publications through a quantitative lens, analyzing them with statistics. This analysis can be evaluative, such as citation analysis, to examine how much work has been done in a particular field, the types of these studies, and how these papers have influenced other research [10]. Bibliometric studies are able to detect worldwide research dynamics and trends in a scientific subject over time in this manner [11]. The authors of this study aimed to conduct a comprehensive and holistic bibliometric analysis of studies on the stapedius muscle and to emphasize the importance of the muscle in scientific research.

MATERIALS AND METHODS

Articles on the stapedius muscle were accessed through the Web of Science (WoS) database using the keywords "stapedius muscle" OR "stapedius," in all fields. The VOSviewer package program (Version 1.6.13, Leiden University: Centre for Science and Technology) was used to perform bibliometric analysis on all publications on the stapedius muscle in WoS that were downloaded using this search approach (access date: 20.11.2023) [12]. The searching strategy diagram can be appreciated in Fig. 1.

Data Analysis

The keywords "stapedius muscle" OR "stapedius" were found in the WoS database search by choosing "all fields." According to the years, 445 articles were examined from 47 different disciplines/fields, the oldest being 1980 and the newest being 2023. The data was analyzed by author-citation-journal-country-institution and keywords, then presented as frequency and percentage.

Main Points;

- Our study indicated an increasing trend in stapedius research since 2011.
- Our keyword analysis is advantageous to the research of hotspots in the field of stapedius muscle.
- Considering the clinical significance of the muscle, it is mainly emphasized in subjects such as hyperacusis, otitis media, birth defects, and cholesteatoma.

RESULTS

548 publications were found throughout the literature review. 445 of them were articles. Of these, 90.11% (401) were written in English. Others were written in German (6.9%), Spanish (1.3%), French (0.4%), Hungarian (0.2%), Polish (0.2%), Portuguese (0.2%), Serbian (0.2%), Turkish (0.2%). Other document types were shown on Fig.2.

The first studies on the stapedius muscle were in the 1980s. It was seen that the most publications related to muscle were in 2020 (22 studies) and the least publications were in 1985 (2 studies). There weren't many articles published between 1980 and 1991. When comparing the total number of articles published throughout all years, The quantity of publications published between 1980 and 1991 was discovered to be less than average (Mean±standard deviation: 10.11±4.39 articles). Since 2011, studies on this topic have exceeded the average number of articles. Fig. 2 shows the distribution of articles on stapedius muscle according to years.

Active Authors and Institutions

The author who wrote the most articles about the stapedius muscle was as follows; Guinan, John J. (11), Counter, S. Allen (11), Borg, E (8), Kawase, Tetsuaki (8), Volk, Gerd Fabian (7), Guntinas-Lichius, Orlando (7), Margolis, Robert H. (6), Feeney, M. Patrick (6), Keefe, Douglas H. (6), Laszig, Roland (5).

The highest ten institutions producing the most articles on the stapedius muscle were as follows; Harvard University (26), Karolinska Institutet (25), Harvard Medical School (16), Massachusetts Eye Ear Infirmary (14), Hannover Medical School (11), Karolinska University Hospital (11), Massachusetts Institute Of Technology Mit (9), Radboud University Nijmegen (8), Tohoku University (8), Friedrich Schiller University of Jena (7).

Popular WoS Categories and Active Research Areas

The highest number of articles were found in the field of otorhinolaryngology. The top ten research areas and numbers of studies related to stapedius muscle in WoS were found to be as follows: Otorhinolaryngology (288), Neurosciences Neurology (109), Audiology Speech Language Pathology (79), Anatomy Morphology (25), Surgery (22), Zoology (15), General Internal Medicine (13), Research Experimental Medicine (13), Pediatrics (11), Radiology Nuclear Medicine Medical Imaging (11).

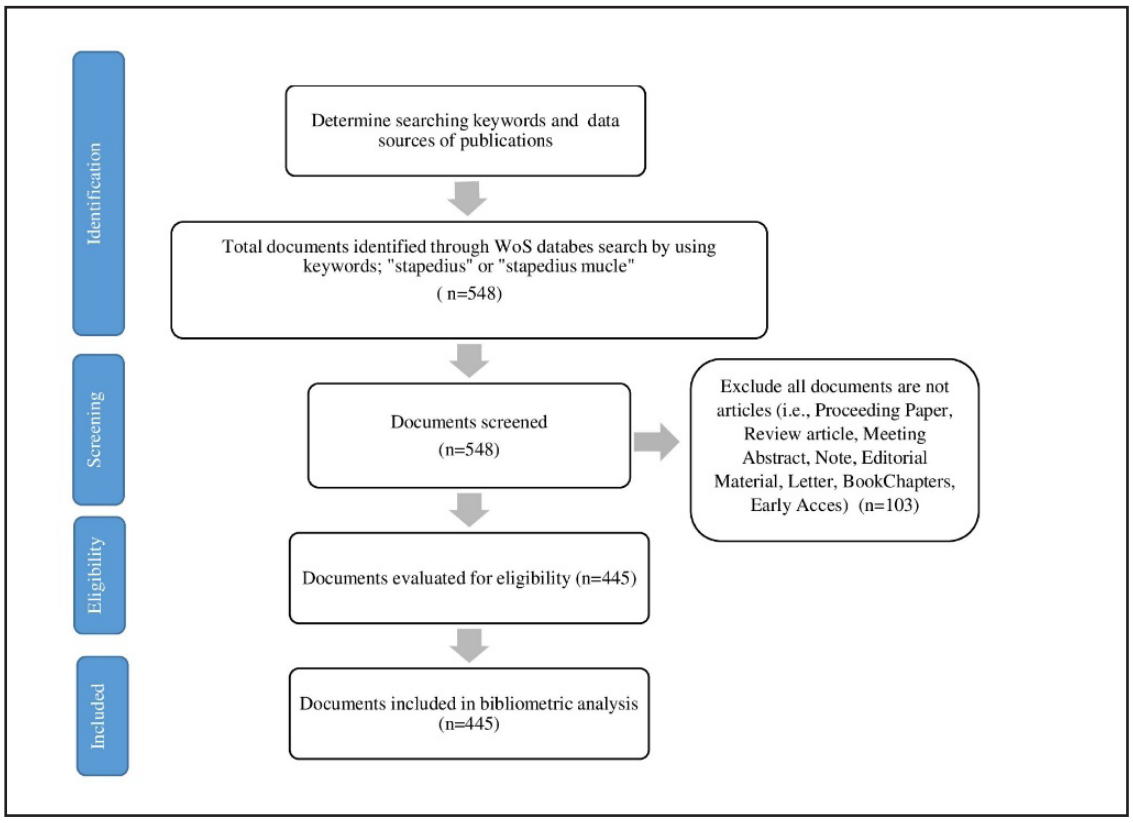

Figure 1. Flow chart diagram for the searching strategy

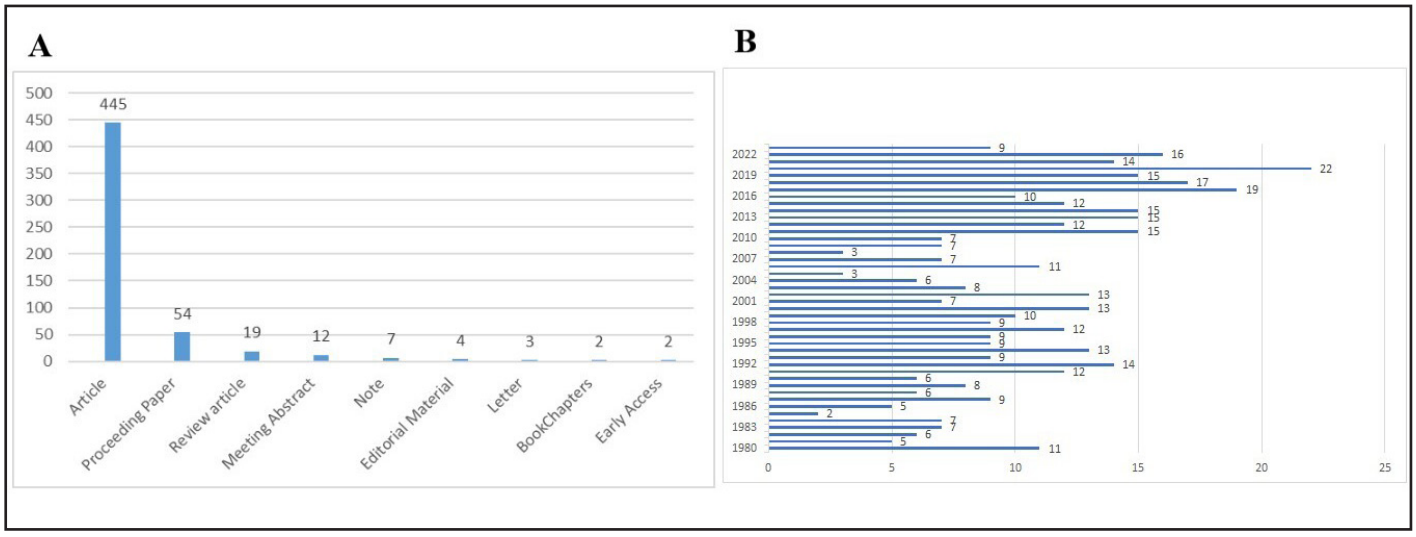

Figure 2. Overview of publications on stapedius muscle. **A:** Distribution according to the types of publications on stapedius muscle. **B:** Distribution of articles on stapedius muscle according to years.

Likewise, in the WoS category, it was seen that the first ranking studies were conducted in the otorhinolaryngology category. The top categories and numbers of stapedius studies in WoS were found to be as follows: Otorhinolaryngology (288), Audiology Speech Language Pathology (79), Neurosciences (68), Clinical Neurology (45), Anatomy Morphology (25), Surgery (22), Zoology (15), Medicine General Internal (13), Medicine Research Experimental (13), Pediatrics (11).

Active Countries

The ten nations with the highest number of producing the most articles about the stapedius were as follows : USA (118), Germany (59), Sweden (34), Austria (26), Japan (26), İtaly (23), Turkey (23), Canada (20), England (18), Netherlands (16). Fig. 3 shows the distribution of the all active countries on the publication of the muscle.

Countries of Co-Authorship Analysis

The network analysis of countries' co-authorship was used to analyze and present regional collaboration. Fig. 3 shows a network analysis of country co-authorship. The amount of documents in each country is represented by the size of the circle. The circle's size and the number of documents are parallel. As the number of documents increases, the circle's size increases. The thickness of the link represents collaboration between countries. The thicker the line, the greater the cooperation between the countries. The USA had the most articles and the first largest total link strength. The main partners of the USA were China, Ecuador, and Sweden. France also ranked second with the highest number of articles and strongest cooperation relations with major partners such as the USA, Canada, Austria, and England.

Active Journals

There were 151 journals that published articles about the stapedius muscle. Ten of these journals had more than ten articles each. As shown in Fig. 4, the majority of papers appeared in *"Acta Oto-laryngologica" (ISSN: 0001-6489*) which is an international journal for translational otolaryngology and head-and neck surgery. The journal presents cutting-edge papers on clinical practice, clinical research and basic sciences. Features of the journal include Inner and Middle Ear, Otoneurology, Audiology, Central Labyrinthine Pathways, Nose/Sinus, Mouth/ Pharynx, Larynx, Salivary Glands, Oncology.

Citation Analysis

A total of 4588 citations were made in the WoS database for studies on stapedius muscle between 1980 and 2023. The ten most cited studies and the number of citations are given below (Table 1) [13-22].

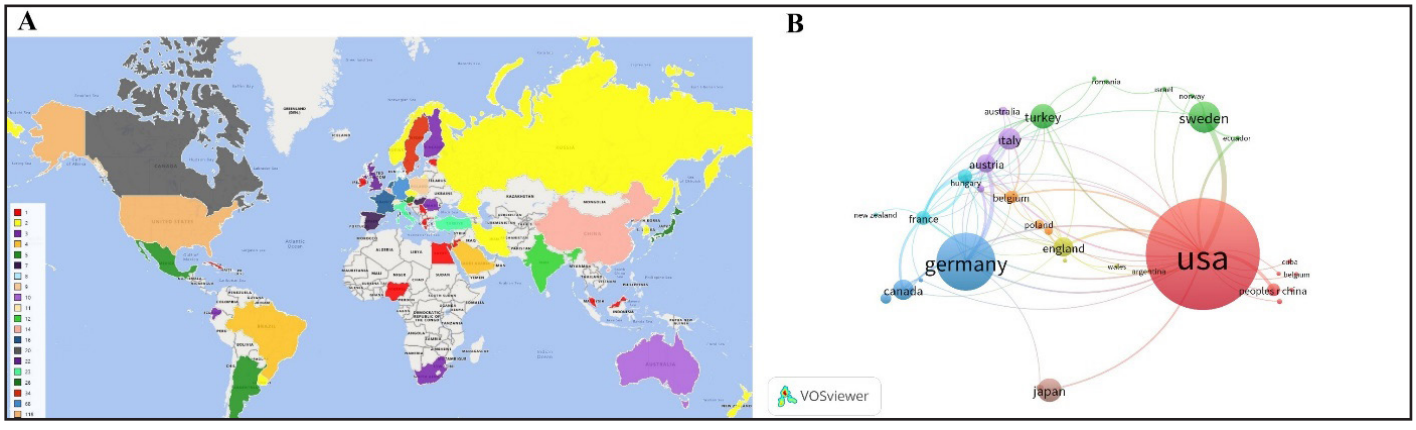

Figure 3. Analysis of publications and countries on stapedius muscle. **A:** The distribution of the active countries on the publications of stapedius muscle. **B:** Network analysis of co-authorship of countries.

Table 1. The ten most cited articles and the number of citations

Article	Citation number	Average citation per year
Peitersen [13]	630	28.64
McCue and Guinan [14]	247	8.23
Brantberg et al. [15]	158	6.87
Gordon et al. [16]	97	4.85
Thompson and Thompson [17]	91	2.76
Cafarelli Dees et al. [18]	75	3.95
Bergenius and Perols [19]	70	2.8
Mukerji et al. [20]	67	4.79
Feeney et al. [21]	61	8.71
Svensson et al. [22]	59	8.43

Keyword Analysis

The facial nerve, stapedius reflex, temporal bone, cochlear implant, and tensor tympani muscle were found to be the most frequently used terms in literature about the stapedius muscle. The rare topics related to the stapedius muscle were determined to be vocalization, stapedius muscle canal, speech discrimination, facial nerve palsy, and Bell's palsy. A prominent keywords map related to stapedius muscle research is displayed in Fig. 4.

DISCUSSION

Examining scientific studies with bibliometric approaches provides an understanding of the place of topics in the literature and offers insights into their popularity and future status [23]. The current study's findings, which examined research on the stapedius muscle worldwide, demonstrated the interest researchers have in the subject and provided quantitative information regarding the muscle's position within the scientific community.

Average number of publications per year, document types, article language, keywords related to this subject and citation analysis per publication were determined for all studies. Furthermore, the most cited works in the field among those covered by the data set were identified. The stapedius muscle has been the subject of 4588 citations in the WoS database; stapedius-related articles have been published in 151 journals, 47 domains, and 51 WoS categories. It is seen that several researches have been studied on the stapedius muscle in a variety of categories and fields.

In terms of the number of publications per year, it was discovered that more publications were made than average after 2011 and that academic interest in the subject area of stapedius muscle increased after 2011, and it was observed that 42.92% of the publications were formed by works published between 2011 and 2023. In terms of publication types, it was discovered that there are 9 different document types, with articles being the

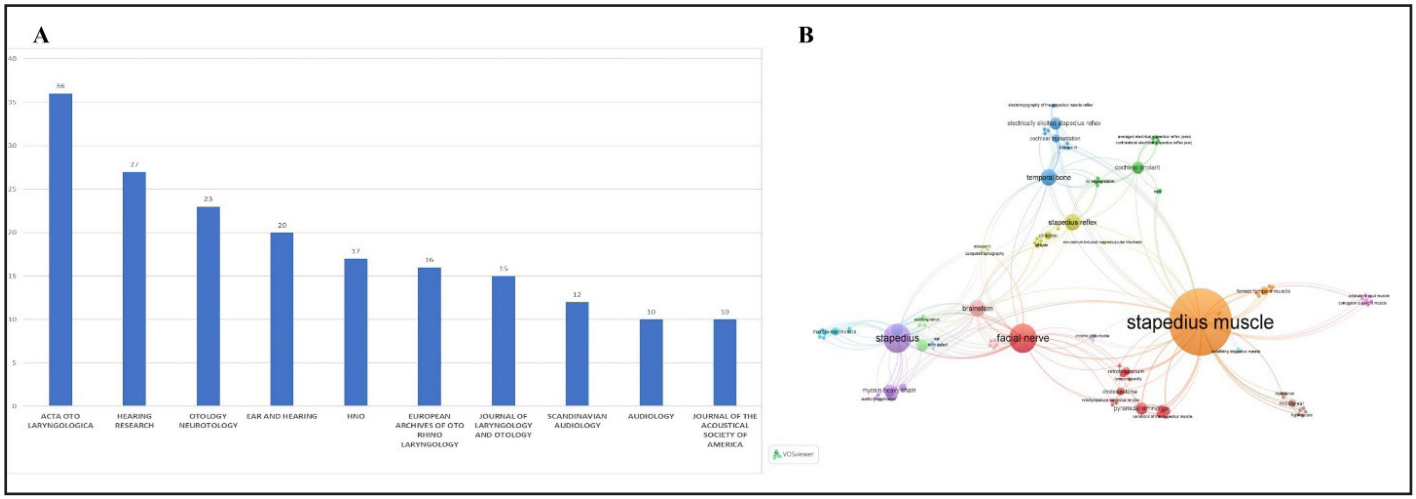

Figure 4. Analysis of journals and research hotspots on stapedius muscle. **A:** The top 10 most active journals that published articles on the stapedius. **B:** The network visualization map for cluster analysis based on keyword analysis on the stapedius

most common study type (81.2%). It was seen that almost all of the publication language of the works was English (90.11%), followed by German (6.9%).

Active country analysis identifies countries with a strong research platform in various disciplines. Cooperation between these countries strengthens the scientific network. It is necessary to increase research co-operation with influential countries and strengthen the network between countries [24]. This study revealed that USA, Germany, Australia, Sweden are the countries that have conducted the most studies on the stapedius muscle. Regarding country collaborations, the USA realized the highest number of cooperation with other countries. It could be said that France, Austria, and Germany guide the studies. It was also concluded that active countries are more effective in co-authorship. The economic size and opportunities of the aforementioned countries may have an impact on the productivity of publications [25]. When we evaluate the contribution of the institutes to stapedius muscle, we could say that the results are parallel to the prolific countries about the topic. The top active universities on this topic seem to be in the United States, Germany, and Sweden.

Keywords in academic studies are primarily used by indexing systems to identify the most relevant matches for a search query in search engines, scholarly databases, and library catalogs. Additionally, keywords are the predictors of the discoverability of academic articles and the keys to how articles are found [26]. We believe that using keyword analysis to study hotspots in the stapedius muscle field is advantageous. Regarding the keyword analysis, it is clear that tympanic cavity and temporal bone studies are closely related to the stapedius muscle. The noteworthy details are that there is a tendency to use computerized tomography and EMG in studies related to the muscle. Considering the clinical significance of the stapedius muscle, it was determined that the muscle is mainly emphasized in subjects such as hyperacusis, otitis media, birth defects, and cholesteatoma. It is seen that studies on the tensor tympani muscle also come to the forefront in the keywords map. In addition, the map analysis shows the stapedius muscle is important in the cochlear implant. In the literature, it was observed that the muscle's relationship with the auditory nerve and facial nerve was examined, it was the focus of studies on auditory functions and auditory reflexes, and it was studied in research conducted with children. Furthermore, analysis shows that the rare topics related to the stapedius muscle were determined to be vocalization, stapedius muscle canal, speech discrimination, facial nerve palsy, and Bell's palsy.

Citations are seen as a sign of scholarly achievement for authors and journals. Finding the articles that have been cited the most is crucial for obtaining high-quality papers about that topic [23]. The top 10 articles on stapedius muscle with the most citations provide valuable information to guide the researchers who want to write articles on this subject. According to a review of the journals where scholarly research on the stapedius muscle have been published, *"Acta Oto-laryngologica" (ISSN: 0001-6489*) had the most published works (n=36). Moreover, 3 articles, in the list of the 10 most cited articles, were found in this journal [13, 15, 19]. We think that the journal is an important source of publications that carry key importance in this field. It is seen that the 10 most cited articles are related to hearing and auditory function and emphasize the importance of the stapedius muscle in this field. In addition, the most cited articles are published in the journals that publish the most studies on this topic.

Regarding the citation analysis, the article written by Peitersen [13]. received the most citations and the most average citations per year. The most cited 10 articles and the number of citations table examined, the articles written by Feeney et al. [21], and Svensson et al. [22] were ranked 9th and 10th in the citation number, but these articles were found to be the second and third most cited articles according to the annual average number of citations.

Higher-quality outcomes, the acquisition of new skills, and interdisciplinary exchange of ideas are all made possible by collaborative research. Multidisciplinary research provides different approaches and perspectives on problems [27]. Since the mid-twentieth century, research has moved away from being done in a single discipline and toward collaboration. The reason for this trend is the result of both increased specialization and the growth of knowledge within the fields of academic inquiry. As a result, interest in collaborative research systems has increased [28]. Category analysis shows that Otorhinolaryngology, AudiologySpeech Language Pathology, Neurosciences, Anatomy Morphology, Surgery, Zoology and Paediatrics are the main categories for stapedius muscle in the WoS. The stapedius muscle was shown to be a part of numerous categories. This might arise from the fact that stapedius muscle is a topic of collaborative research.

Limitations

The current study has a few limitations. This study analyzed only published articles that were included in the WoS database. There was no use of databases like Scopus and PubMed. Journals from non-English speaking nations may therefore be underlooked. Furthermore, the analysis only included articles; other categories were left out. The lack of consideration for self-citations in the citation analysis could have led to a bias in the quantity of citations for certain nations, journals, and authors.

CONCLUSION

To the best of our knowledge, we could say that this study is the first bibliometric analysis on the stapedius muscle. A comprehensive summary of 445 articles on the stapedius muscle in WoS up to November 20, 2023 is presented in this study. In addition, the most interested and cited journals related to stapedius muscle were included. Trending topics and rare topics studied in conjunction with stapedius muscle were presented. Our study is a guideline for researchers who plan to study on the stapedius muscle.

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REFERENCES

[1] Dalmia D, Behera S (2017) Congenital absence of stapedius muscle and tendon: Rare finding in two cases. Indian Journal of Otology. 23(1):43. https://doi.org/10.4103/0971-7749.199511

[2] Prasad KC, Azeem Mohiyuddin SM, Anjali PK, Harshita TR, Indu Varsha G, Brindha HS (2019) Microsurgical Anatomy of Stapedius Muscle: Anatomy Revisited, Redefined with Potential Impact in Surgeries. Indian J Otolaryngol Head Neck Surg. 71(1):14-18. https://doi.org/10.1007/s12070-018-1510-5

[3] Fournier P, Paquette S, Paleressompoulle D, Paolino F, Devèze A, Noreña A (2022) Contraction of the stapedius and tensor tympani muscles explored by tympanometry and pressure measurement in the external auditory canal. Hear Res. 420:108509 https://doi.org/10.1016/j.heares.2022.108509

[4] Edmonson A, Iwanaga J, Olewnik Ł, Dumont AS, Tubbs RS (2022) The function of the tensor tympani muscle: a comprehensive review of the literature. Anat Cell Biol. 55(2):113-117. https://doi.org/10.5115/acb.21.032

[5] Saxena U, Singh BP, Kumar SBR, Chacko G, Bharath K (2020) Acoustic Reflexes in Individuals Having Hyperacusis of the Auditory Origin. Indian J Otolaryngol Head Neck Surg. 72(4):497-502. https://doi.org/10.1007/s12070-020-02002-9

[6] Takezawa K, Townsend G, Ghabriel M (2018) The facial nerve: anatomy and associated disorders for oral health professionals. Odontology. 106(2):103-116. https://doi.org/10.1007/s10266-017-0330-5

[7] Zhang Z, Tang R, Wu Q, Wang Z, Wang Z (2023) Stapedius muscle: Don't mistake it for a branch of the facial nerve in images. Auris Nasus Larynx. 50(5):749-756. https://doi.org/10.1016/j.anl.2023.02.003

[8] Marquez P, Volk GF, Maule F, Korth D, Bitter T, Koscielny S, Aschenbach R, Guntinas-Lichius O (2021) The use of a surgical planning tool for evaluating the optimal surgical accessibility to the stapedius muscle via a retrofacial approach during cochlear implant surgery: a feasibility study. Int J Comput Assist Radiol Surg. 16(2):331-343. https://doi.org/10.1007/s11548-020-02288-8

[9] Elden LM, Wetmore RF, Potsic WP (2012) Otolaryngologic Disorders. Pediatric Surgery. 2012:707-28. https://doi: 10.1016/B978-0-323-07255-7.00055-6.

[10] Danvila del Valle I, Estevez-Mendoza C, Lara F (2019) Human resources training: A bibliometric analysis. Journal of Business Research. 101:627-636 https://doi.org/10.1016/j.jbusres.2019.02.026

[11] Kiraz M, Demir E (2020) A Bibliometric Analysis of Publications on Spinal Cord Injury During 1980-2018. World Neurosurg. 136:e504-e513. https://doi.org/10.1016/j.wneu.2020.01.064

[12] van Eck NJ, Waltman L (2010) Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics. 84(2):523-538. https://doi.org/10.1007/s11192-009-0146-3

[13] Peitersen E (2002) Bell's palsy: the spontaneous course of 2,500 peripheral facial nerve palsies of different etiologies. Acta Otolaryngol Suppl. 122(549):4-30. https://doi.org/10.1080/000164802320401694

[14] McCue MP, Guinan JJ Jr (1994) Acoustically responsive fibers in the vestibular nerve of the cat. J Neurosci. 14(10):6058-70. https://doi.org/10.1523/jneurosci.14-10-06058.1994

[15] Brantberg K, Bergenius J, Mendel L, Witt H, Tribukait A, Ygge J (2001) Symptoms, findings and treatment in patients with dehiscence of the superior semicircular canal. Acta Otolaryngol. 121(1):68-75. https://doi.org/10.1080/000164801300006308

[16] Gordon KA, Papsin BC, Harrison RV (2004) Toward a battery of behavioral and objective measures to achieve optimal cochlear implant stimulation levels in children. Ear Hear. 25(5):447-63. https://doi.org/10.1097/01.aud.0000146178.84065.b3

[17] Thompson AM, Thompson GC (1991) Posteroventral cochlear nucleus projections to olivocochlear neurons. J Comp Neurol. 303(2):267-85. https://doi.org/10.1002/cne.903030209

[18] Cafarelli Dees D, Dillier N, Lai WK, von Wallenberg E, van Dijk B, Akdas F, et al. (2005) Normative findings of electrically evoked compound action potential measurements using the neural response telemetry of the Nucleus CI24M cochlear implant system. Audiol Neurootol. 10(2):105-16. https://doi.org/10.1159/000083366

[19] Bergenius J, Perols O (1999) Vestibular neuritis: a follow-up study. Acta Otolaryngol. 119(8):895-9. https://doi.org/10.1080/00016489950180243

[20] Mukerji S, Windsor AM, Lee DJ (2010) Auditory brainstem circuits that mediate the middle ear muscle reflex. Trends Amplif. 14(3):170-91. https://doi.org/10.1177/1084713810381771

[21] Feeney MP, Keefe DH, Hunter LL, Fitzpatrick DF, Garinis AC, Putterman DB, McMillan GP (2017) Normative Wideband Reflectance, Equivalent Admittance at the Tympanic Membrane, and Acoustic Stapedius Reflex Threshold in Adults. Ear Hear. 38(3):e142-e160. https://doi.org/10.1097/aud.0000000000000399

[22] Svensson RB, Herchenhan A, Starborg T, Larsen M, Kadler KE, Qvortrup K, Magnusson SP (2017) Evidence of structurally continuous collagen fibrils in tendons. Acta Biomater. 50:293-301. https://doi.org/10.1016/j.actbio.2017.01.006

[23] Bozkurt AS (2023). Bibliometric Analysis of the Published Studies on the Kindling Model between 1980 and 2023. Eur J Ther. 29(2):188–193. https://doi.org/10.58600/eurjther.20232902-396.y

[24] Sitthi-Amorn C, Somrongthong R (2000) Strengthening health research capacity in developing countries: a critical element for achieving health equity. Bmj. 321(7264):813-7. https://doi.org/10.1136/bmj.321.7264.813

[25] Golpinar M, Demir E (2020) Global Research Output of the Cerebellum: Yesterday, Today, and Tomorrow. Journal of the Anatomical Society of India. 69(3):155-165. https://doi.org/10.4103/JASI.JASI_114_20

[26] Corrin L, Thompson K, Hwang G-J, Lodge J (2022) The importance of choosing the right keywords for educational technology publications. Australasian Journal of Educational Technology. 38(2): 1–8. https://doi.org/10.14742/ajet.8087

[27] Bansal S, Mahendiratta S, Kumar S, Sarma P, Prakash A, Medhi B (2019) Collaborative research in modern era: Need and challenges. Indian J Pharmacol. 51(3):137-139. https://doi.org/10.4103/ijp.IJP_394_19

[28] Dalton A, Wolff K, Bekker B (2021) Multidisciplinary Research as a Complex System. The International Journal of Qualitative Methods. 20:16094069211038400. https://doi.org/10.1177/16094069211038400

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