INDEX COPERNICUS INTERNATIONAL

Rare proliferative and inflammatory pathologies within the temporal bone – a literature review

Rzadkie patologie rozrostowo-zapalne zlokalizowane w kości skroniowej – przegląd piśmiennictwa

Adam Roszkowski[1], Alicja Witkowska[1], Piotr Baranek[1], Anna Rzepakowska[2], Emilia Wnuk[3], Kazimierz Niemczyk[2]

[1]Students' Research Group at the Department and Otolaryngology, Medical University of Warsaw
[2]Department and Otolaryngology, Medical University of Warsaw
[3]2nd Department of Clinical Radiology, Medical University of Warsaw

Article history: Received: 20.05.2019 Accepted: 23.06.2019 Published: 26.06.2019

ABSTRACT:

Introduction: Proliferative-inflammatory pathologies may occupy the temporal bone, resulting in: hearing loss, vestibular dysfunction, and neuropathies from cranial nerve compression. Although their occurrence is episodic, the appropriate diagnostic procedure is extremely important to achieve expected therapeutic effect.

Aim: The aim of study was characterization of selected proliferative-inflammatory pathologies that may occupy the temporal bone: fibrous dysplasia, inflammatory pseudotumor, osteoradionecrosis, and presentation of diagnostic methods for the differentiation of these diseases as well as discussion on appropriate therapeutic options. Fibrous dysplasia (FD) is a slowly progressive, benign bone disorder of unknown etiology characterized by abnormal proliferation of fibrous tissue. Inflammatory pseudotumor (IPT) is a rare, non-malignant inflammatory process of unknown etiology, characterized by connective tissue proliferation and infiltration of inflammatory cells. Osteoradionecrosis of the temporal bone (TB-ORN) is a rare but potentially fatal complication of radiotherapy for head and neck cancer.

Results: Due to the similarity of symptoms with typical inflammatory conditions of middle ear (pain, otorrhea, hearing loss), selected disorders may be a dilemma regarding the diagnosis and proper further treatment. The clinical examination is mandatory, however radiological imaging may demonstrate the presence of specific changes and direct the diagnosis. The computed tomography (CT) of fibrous dysplasia shows the abnormal organization of the bone structure. Magnetic resonance (MRI), as the most sensitive for inflammatory pseudotumors, visualizes inflammatory infiltration in soft tissues. The CT of temporal bone identifies the erosion in the course of osteoradionecrosis. However in all cases the final diagnosis may be establish using histopathological examination and after exclusion of the neoplastic process.

KEYWORDS: fibrous dysplasia, inflammatory pseudotumor, osteoradionecrosis, proliferative-inflammatory pathologies, skull base, temporal bone

STRESZCZENIE:

Wprowadzenie: Patologie rozrostowo-zapalne mogą zajmować kość skroniową, powodując różnorodne objawy, zależne od ich umiejscowienia: niedosłuch, dysfunkcję przedsionkową i neuropatie spowodowane kompresją nerwów czaszkowych. Jakkolwiek ich występowanie jest rzadkie, istotne jest odpowiednie postępowanie diagnostyczne, które skutkuje wdrożeniem właściwej terapii.

Cel: Celem pracy była charakterystyka kliniczna i przegląd metod diagnostycznych oraz zaleceń terapeutycznych w wybranych patologiach rozrostowo-zapalnych kości skroniowej: dysplazji włóknistej, inflammatory pseudotumor, osteoradionekrozie. Dysplazja włóknista (*fibrous dysplasia*) jest powoli postępującym, łagodnym zaburzeniem kostnym o nieznanej etiologii, charakteryzującym się nieprawidłową proliferacją tkanki włóknistej. IPT (*inflammatory pseudotumor*) to nienowotworowy proces zapalny o nieznanej etiologii, charakteryzujący się proliferacją tkanki łącznej i naciekiem komórek zapalnych. Osteoradionekroza kości skroniowej (TB-ORN) to rzadkie, ale potencjalnie śmiertelne powikłanie leczenia radioterapią nowotworów głowy i szyi.

Wnioski: Ze względu na podobieństwo objawów z powszechnymi patologiami zapalnymi ucha środkowego (bóle, wycieki z uszu, niedosłuch) prezentowane rzadkie schorzenia mogą stwarzać problem diagnostyczny i terapeutyczny. Dokładne badanie kliniczne jest niezbędne, ale poszerzenie diagnostyki o badania obrazowe, może przyspieszyć ukierunkowanie diagnozy. W przypadku dysplazji włóknistej obrazy tomografii komputerowej (CT) wykazują charakterystyczną przebudowę

 DOI: 10.5604/01.3001.0013.2564

struktury kostnej. W przypadku pseudoguzów zapalnych najbardziej czułym narzędziem wydaje się badanie rezonansu magnetycznego (MRI), które obrazuje nacieki zapalne w tkankach miękkich. Badanie CT kości skroniowej skutecznie uwidocznia ubytki i erozję w przebiegu osteoradionekrozy. W każdym z powyższych przypadków niezbędne jest wykonanie badania histopatologicznego w celu wykluczenia procesu nowotworowego.

SŁOWA KLUCZOWE: dysplazja włóknista, kość skroniowa, osteoradionekroza, patologie rozrostowo-zapalne, podstawa czaszki, pseudoguz zapalny

SHORT

IPT – inflammatory pseudotumor
IMT – inflammatory myofibroblastic tumor
FD – fibrous dysplasia
TB-ORN – temporal bone-osteoradionecrosis
ORN – osteoradionecrosis
CT – computed tomography
HRCT – high-resolution computed tomography
MRI – magnetic resonance imaging
EBV – Epstein-Barr virus
HHV-8 – Human herpes virus-8

INTODUCTION

Depending on their exact location, proliferative-inflammatory pathologies affecting the temporal bone may cause diverse symptoms such as hearing loss, vestibular dysfunction, and neuropathies from cranial nerve compression. Although their occurrence is episodic, appropriate diagnostic procedures are extremely important to allow for differentiation of these rare pathologies after more common disorders are ruled out by clinicians, and hence for proper diagnosis and appropriate treatment.

OBJECTIVE

The aim of the study was to characterize the rare proliferative-inflammatory pathologies that may affect the temporal bone, including fibrous dysplasia, inflammatory pseudotumor, and osteoradionecrosis, to present diagnostic methods allowing for differentiation of these diseases, and to discuss the appropriate therapeutic options.

CHARACTERISTICS OF RARE PATHOLOGIES

Fibrous dysplasia (FD) is a congenital disorder characterized by a defect in differentiation and maturation of osteoblasts. Normal bone is replaced by fibrous tissue and disorganized trabeculae of immature bone tissue [1–3]. It was first reported by Lichtenstein in 1938 [4]. The estimated incidence of FD ranges between 1 and 2 per 30,000 individual; the disease is more common in children, adolescents, and young adults. More than 90% of recently diagnosed cases occur in females [5] whereas higher prevalence in male patients was observed in the past [6]. The mean age at diagnosis is 30 years. The prevalence of the pathology is characterized by racial predilection, with Caucasians accounting for 80% of all cases and Asians representing only 1% of the entire patient population [6].

The pathology may present in one of three variants Monostotic syndrome is the most common form (70%), and one characterized by the most benign course. It affects mainly patients between the ages of 10 and 30. Polyostotic fibrous dysplasia is diagnosed when several bones are involved, usually on the same side of the body; this form is observed in 30–51% of cases. McCune-Albright syndrome (ca. 3% of patients) is the most severe form of fibrous dysplasia characterized by concurrence of classic polyostotic presentation, skin hyperpigmentation, and premature puberty [7].

FD affecting temporal bone alone was first characterized by Schlumberger in 1946 [8]. It is a rare proliferative pathology, with slightly more than 100 cases reported in this location, most of them occurring within the pediatric population.

Inflammatory pseudotumor (IPT), also referred to in the literature as inflammatory myofibroblastic tumor (IMT) is a benign inflammatory process of unknown etiology, characterized by connective tissue proliferation and infiltration of inflammatory cells. IPT was first described by Gleeson and Busse in 1903 while the first skull base location was reported by Birch-Hirchfeld in 1905 [15]. Lungs are the most common location of this type of lesions. The involvement of the head and neck region is reported in 5% of cases whereas temporal bone involvement is very rare [16]. The disorder affects all individuals regardless of gender or age; however, a peak incidence may be observed in the middle age period [17]. Due to its low prevalence, IPT is frequently not included in differential diagnostics; in the reported cases, initial diagnoses ranged from mastoiditis or chronic otitis media to neuroma or meningioma [17].

Although the pathogenesis of IPT is unknown, suspected causes include autoimmune or infectious processes. Some hypotheses pointed to abnormal immune responses to EBV or HHV-8 viral antigens in IPT patients [18]. To date, no correlation could be demonstrated between these viruses and the increased risk of IPTs within the temporal bone [17].

Osteoradionecrosis is the necrosis of the temporal, usually caused by earlier radiotherapy for head and neck cancer, particularly nasopharyngeal and parotid gland cancers, although idiopathic forms have also been reported [24]. It is defined as a disorder in bone structure not yielding to the applied treatment within 3 months [25]. The development of this pathology is promoted by irradiation responsible for bone tissue nutrition and regeneration of bone disorders referred to as 3xH – hypoxia, hypovascularity, and hypocellularity. These processes lead to disturbed bone turnover and formation of non-healing wounds. Microbial flora also plays an important role in the pathogenesis of the disease. Bacterial biofilm formed on the exposed bone surface is responsible for further skin, mucous membrane, and bone damage [25]. Factors

Fig. 1. Comparison of symptoms reported by patients with fibrous dysplasia (FD), inflammatory pseudotumor (IPT), or osteoradionecrosis of temporal bone (TB--ORN) on the basis of literature data.

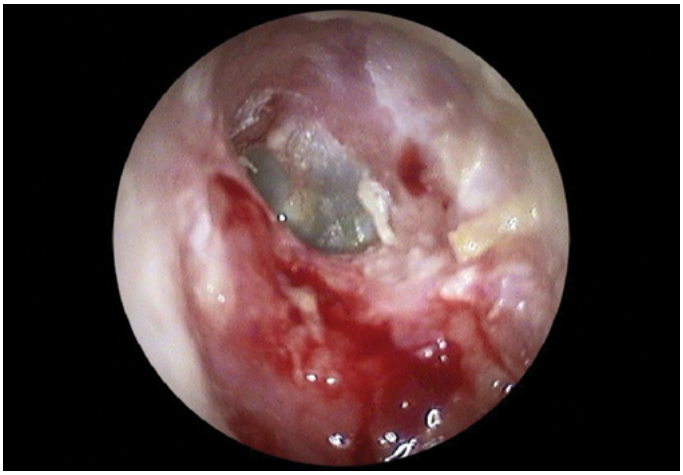

Fig. 2. Otoscopic image of the auditory canal and tympanic membrane in a patient with osteoradionecrosis of temporal bone; the patient had a history of radiation therapy administered adjuvantly to lingual cancer 14 years before.

such as concomitant diabetes, advanced age, immunosuppression or smoking also increase the risk of IPT in patients after radiotherapy within the head and neck region [26, 30]. The complication has a morbidity rate of ca. 8.5% [28]. The value, however, may be underestimated due to the late onset of osteoradionecrosis which may develop as late as 40 years after radiation therapy [28]. As of this day, no consensus position has been agreed upon with regard to safe doses of head and neck radiotherapy ensuring prevention of potential temporal bone osteoradionecrosis. Only a moderate correlation between the radiation dose and the onset of complication was demonstrated [27, 30].

SYMPTOMS

Symptoms reported by the patients are related to the anatomical location of the pathology.

The most common symptoms of temporal bone FD include conductive hearing loss and narrowing of the external auditory canal. Receptive hearing loss has also been reported in the literature [10]. Facial nerve paresis is a rare complication of FD. Currently, the involvement of the facial nerve canal due to progression of temporal bone dysplasia is estimated to occur in about 4-5% of cases [6]. Clinical presentation also includes headache, tinnitus and sudden deafness, and episodic tinnitus with nausea and vomiting [11].

The most common symptoms of IPT include [17]:

- progressive hearing loss – 53.8%;
- otalgia – 38.5%;
- otorrhea – 33.,3%;
- tinnitus – 20.5%;
- vertigo – 15.4%;
- facial nerve paresis – 10.25%;
- headache – 7.7%;
- equilibrium disorders – 5.1%;
- double vision – 5.1%.

Patients with osteoradionecrosis initially complain of unpleasant smell from their ears (100%), headaches (93%), purulent or bloody otorrhea (85%), periodical bleeding from the nose (75%) and acute ear pain (50%). Clinical examination may reveal temporal bone exposure (73.9-100%), purulent lesions (100%), fistulas (53.2%), tympanic membrane defects (39.1%) and skin defects (34.8%). Other possible disorders include impaired hearing (55%), facial nerve paresis (10%) and equilibrium disorders (10%) [24,25,29]. Fig. 1.

- Niedosłuch – progressive hearing loss;
- Otalgia – otalgia;
- Wyciek z ucha – otorrhea;
- Szumy uszne – tinnitus;
- Zawroty głowy – vertigo.

DIAGNOSTIC IMAGING

The standard imaging modality in middle ear pathologies is the computed tomography (CT) of temporal bones facilitating precise assessment of the small bone-delimited space of the tympanic cavity, evaluation of the trabeculae and identification of potential soft-tissue masses or shadings within the middle ear. It does not, however, allow for precise differentiation of shadings within the tympanic membrane. A more detailed characterization may be provided by magnetic resonance imaging (MRI) which is better suited for differentiation of soft tissues from inflammatory processes. MRI is also the crucial tool for the assessment of inner ear structures.

Therefore, authors reporting diffuse pathologies within the tympanic bone suggest that both modalities, i.e. CT and MRI, are frequently warranted [17].

Fibrous dysplasia may be diagnosed from its characteristic features on CT scans. Three classic forms of FD may be differentiated in radiological imaging, namely the pagetoid (56%), sclerotic (23%), and cystic forms (21%). Pagetoid form is characterized by the presence of the areas of mixed, non-homogeneous, sclerotic-lytic areas. The sclerotic pattern presents with homogeneous density fragments within the affected bone. The cystic form is characterized

by the presence of oval cysts with sclerotic margins [7]. Sclerotic and cystic forms may occur simultaneously. The CT features of FD depend on the number of bones affected as well as on the mineral density of these bones. It is usually hard to identify clear borders between healthy and pathological tissues. The periosteum is usually conserved, although it may be thinned; at the same time, trabecular bone is filled with fibrous tissue and disorganized trabeculae. The most common radiological pattern of temporal bone DT is the pagetoid form characterized by non-uniformly increased density, loss of the normal trabecular pattern and increased thickness of bones. Fig. 2.

MRI scans may vary from low to high intensity in T1- and T2-weighed images with different contrast enhancement parameters. For this reason, MRI scans are not routinely recommended in cases with characteristic presentation of FD in CT scans and lack of neurological symptoms. Diagnostics of inflammatory pseudotumors requires combination of both CT and MRI scans. The MRI scan facilitates more precise characterization of the pathology. As shown by the analysis of literature-reported cases, most IPT foci were isointense in T1-weighted images and hypointense in T2-weighted images. In addition, the lesions were contrast-enhanced, facilitating the diagnosis being made in combination with available clinical data [17].

In case of TB-ORN, diagnostic examinations should include a CT scan of temporal bones for visualization of erosion areas (90%), swelling of mastoid process air cells (90%), sclerotization of the mastoid process (25%), air vesicles within the soft tissue (30%), temporomandibular joint disorders or erosion of condylar processes (15%). MRI scans are performed only if dissemination of the process into the cranial cavity is suspected.

HISTOPATHOLOGICAL EXAMINATION

The incidence of spontaneous malignant transformation of FD amounts to about 0.4% of cases with osteosarcomas amounting to more than 60% of malignancies [12]. The concurrence of cancer and FD is 400 times higher than the percentage of malignant transformations to form an osteosarcoma [13]. Open biopsy is the preferred method for the collection of IPT specimens for histopathological examination. Inflammatory pseudotumors are characterized by the presence of fibrosis and infiltration (most commonly lymphocytic and plasmocytic) related to both acute and chronic inflammation [19]. Infiltration of B and T cells is a characteristic feature of inflammatory tumors which allows us to differentiate this pathology from other lymphoproliferative disorders such as lymphomas [20]. In the case of osteonecrosis, histopathological examination should be performed as soon as possible so as to exclude tumor recurrence.

TREATMENT

The aforementioned diagnostic methods are aimed at selection of appropriate modality and intensity of treatment.

In the case of FD, conservative treatment includes administration of bisphosphonates albeit their therapeutic efficacy is being questioned.

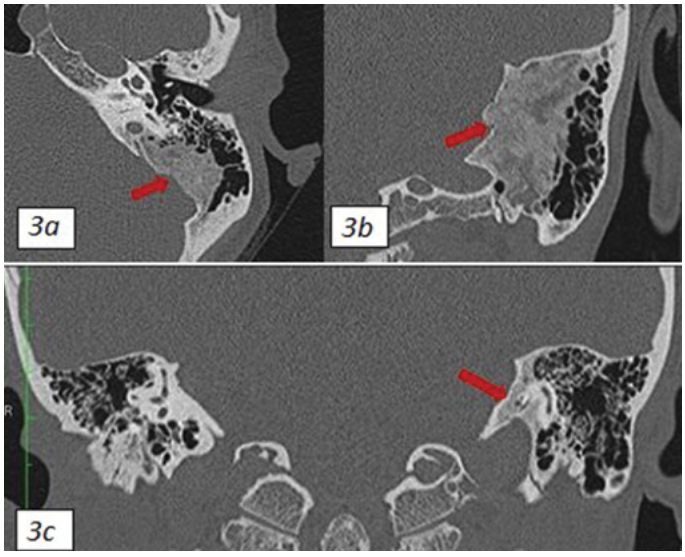

Fig. 3. CT scanning reconstruction of temporal bone reveals mastoid part thickening with maintenance of cortical layer and evident "frosted glass" remodeling of bone structure (red arrow). Image typical for FD: 2A – transverse plane 2b and 2 c – frontal plane. Red arrows indicate abnormal bone remodeling foci.

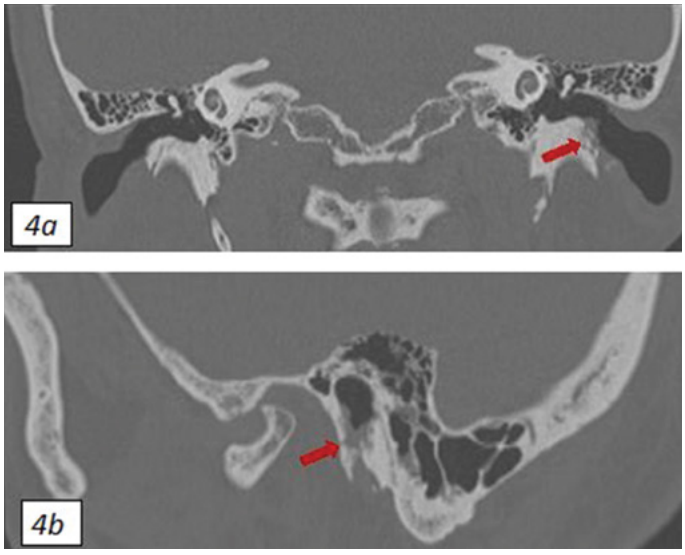

Fig. 4. CT scanning reconstruction of temporal bone reveals destruction of the inferior wall of the auditory canal (red arrow) with small pathological soft tissue mass bulging into the canal lumen. Osteonecrosis was diagnosed following additional analysis of histopathological data: 3A – transverse projection, 3b – oblique projection reconstruction.

FD has the tendency towards remaining inactive after puberty, and therefore caution is recommended when making decisions regarding surgical treatment. In aggressive or symptomatic FD, including FD involving the inner ear or skull base structures, complete resection of pathological bone and its subsequent reconstruction is required. In patients in whom tympanic cavity and mastoid cavity are affected, mastoidectomy and tympanoplasty or subtotal petrosectomy should be considered. Despite the treatment, recurrence of FD is possible and therefore long-term follow-up is required.

Due to the rare prevalence of IPTs within the temporal bone, no consensus position has been agreed upon with regard to the treatment of this pathology. Oral glucocorticosteroids seem to be the

first treatment of choice as they lead to significant improvement in 80% of patients. Intravenous steroid therapy should be taken into consideration in patients with rapidly progressive changes [17]. Radiation therapy is another proposed treatment modality and should be taken into consideration in patients refractory or intolerant to steroids [21]. Extensive surgical treatment (tympanoplasty, petrosectomy) remains an alternative treatment modality. Surgical intervention is warranted in cases of aggressive course of the inflammatory tumor so as to prevent the involvement of central nervous system structures [22]. Due to the absence of tumor capsule, resection involving a healthy tissue margin is recommended to prevent IPT recurrence [23].

Conservative treatment of benign forms of osteoradionecrosis consists in debridement of lesions and removal of necrotic tissue, possibly accompanied by appropriate antibiogram-based topical antibiotic therapy. In addition, treatment with gentian violet is recommended on pathological lesions [28]. In the case of infection or intense pain, intravenous antibiotic therapy should be included periodically [30]. Hyperbaric therapy was taken into consideration; however, no evidence is available to support the efficacy of such a treatment in ORN. While conservative treatment is aimed at controlling the osteoradionecrotic process, it does not lead to the healing of bone defects [24, 26, 30]. Besides the aforementioned therapeutic interventions, severe forms of ORN may require surgical removal of necrotic bone and reconstruction of the defect using skin flaps or free grafts [28, 30].

SUMMARY

In order to optimize and improve the quality and accuracy of diagnosis, otolaryngologists should be aware of pathologies rarely encountered in clinical practice yet characterized by complex course and systemic complications. Differential diagnostics of pathologies within the temporal bone should include the possibility of fibrous dysplasia, inflammatory pseudotumor, and osteoradionecrosis.

FD is diagnosed on the basis of high-resolution CT scans. MRI is useful for the diagnosis of cases with atypical CT presentation and cases involving neurological complications.

In cases of IPT, combination of CT and MRI scans is warranted. Biopsy is required for final diagnosis.

In cases of TB-ORN, diagnosis is made on the basis of patient history (radiation treatment) and characteristic features in CT scans. Biopsy is performed to rule out potential malignancy.

References

1. Maroldi R, Farina D, Palvarini L, Marconi A, Gadola E, Menni K, Battaglia G. Computed tomography and magnetic resonance imaging of pathologic conditions of the middle ear. Eur J Radiol. 2001 Nov;40(2):78-93.
2. Pardo-Maza A, Lassaletta L, Ruiz-Bravo E, Perez-Mora R, Peñarrocha J, Gavilan J. Fibrous dysplasia of the temporal bone secondary to ear surgery: a case report. J Med Case Rep. 2015 Jun 2; 9:129
3. Boyce AM, Brewer C, DeKlotz TR, Zalewski CK, King KA, Collins MT, Kim HJ. Association of Hearing Loss and Otologic Outcomes With Fibrous Dysplasia. JAMA Otolaryngol Head Neck Surg. 2018 Feb 1;144(2):102-107
4. Sinha SN, Sardana DS. Fibrous dysplasia of ethmoid. J Laryngol Otol. 1968 Oct;82(10):931-6
5. Lustig LR, Holliday MJ, McCarthy EF, Nager GT. Fibrous dysplasia involving the skull base and temporal bone. Arch Otolaryngol Head Neck Surg. 2001 Oct;127(10):1239-47
6. Megerian CA, Sofferman RA, McKenna MJ, Eavey RD, Nadol JB Jr. Fibrous dysplasia of the temporal bone: ten new cases demonstrating the spectrum of otologic sequelae. Am J Otol 1995; 16:408-19
7. Kimitsuki T, Komune S. Asymptomatic fibrous dysplasia of the temporal bone. J Laryngol Otol 2015; 129:42–5
8. Schlumberger HG. Fibrous dysplasia of single bones (monostotic fibrous dysplasia). Mil Surg. 1946; 99:504–27
9. Kim YH, Song J-J, Choi HG, Lee JH, SH O, Chang SO, et al. Role of surgical management in temporal bone fibrous dysplasia. Acta Otolaryngol. 2009; 129:1374–9
10. Burke AB, Collins MT, Boyce AM. Fibrous dysplasia of bone: craniofacial and dental implications. Oral Dis. 2017 Sep;23(6):697-708
11. Mierzwiński J, Kosowska J, Tyra J, Haber K, Drela M, Paczkowski D, Burduk P. Different clinical presentation and management of temporal bone fibrous dysplasia in children. World J Surg Oncol. 2018 Jan 15;16(1):5
12. Schwartz DT, Alpert M. The malignant transformation of fibrous dysplasia. Am J Med Sci 1964; 247:1-20
13. Lambert PR, Brackmann DE. Fibrous dysplasia of the temporal bone: the use of computerized tomography. Otolaryngol Head Neck Surg 1984; 92:461-7
14. Jee WH, Choi KH, Choe BY, et al. Fibrous dysplasia: MR imaging characteristics with radiopathologic correlation. AJR Am J Roentgenol 1996;167(6):1523–7
15. Birch–Hirschifield A. Zur Diagnostic and Pathologic der Orbital Tumoren. Bericht uber die Zusammenkunft der Deutschen Ophthalmologischen Gesellschaft 1905; 32:127–135
16. Coffin CM, Watterson J, Priest JR, Dehner LP. Extrapulmonary inflammatory myofibroblastic tumour (inflammatory psuedotumour): a clinicopathologic and immunohistochemical study of 84 cases. Am J Surg Pathol. 1995; 19:859–872
17. Spinazzi EF, Desai SV, Fang CH, Jyung RW, Liu JK, Baredes S, Eloy JA. Lateral skull base Inflammatory pseudotumor: A systematic review. Laryngoscope. 2015 Nov;125(11):2593-600
18. Arber DA, Kamel OW, van de Rijn M, Davis RE, Medeiros LJ, Jaffe ES, Weiss LM. Frequent presence of the Epstein-Barr virus in inflammatory pseudotumor. Hum Pathol 1995;26(10):1093-1098
19. Patnana M, Sevrukov AB, Elsayes KM, Viswanathan C, Lubner M, Menias CO. Inflammatory pseudotumor: the great mimicker. AJR Am J Roentgenol 2012; 198:217–227
20. Narla LD, Newman B, Spottswood SS, Narla S, Kolli R. Inflammatory pseudotumor. Radiographics. 2003;23(3):719-29
21. Jacobs D, Galetta S. Diagnosis and management of orbital pseudotumor. Curr Opin Ophthalmol 2002; 13:347–351
22. Lee JH, Jung MK, Song CE, et al. Concomitant inflammatory pseudotumor of the temporal bone and lung: a case report. Ear Nose Throat J 2007; 86:614–616
23. Ajibade DV, Tanaka IK, Paghdal KV, Mirani N, Lee HJ, Jyung RW. Inflammatory pseudotumor (plasma cell granuloma) of the temporal bone. Ear Nose Throat J 2010; 89:1–13
24. Pathak I, Bryce G. Temporal bone necrosis: diagnosis, classification, and management. Otolaryngol Head Neck Surg. 2000 Sep;123(3):252-7
25. Hao SP, Chen HC, Wei FC, Chen CY, Yeh AR, Su JL. Systematic management of osteoradionecrosis in the head and neck. Laryngoscope. 1999 Aug;109(8):1324-7
26. Ahmed S, Gupta N, Hamilton JD, Garden AS, Gidley PW, Ginsberg LE. CT findings in temporal bone osteoradionecrosis. J Comput Assist Tomogr. 2014 Sep-Oct;38(5):662-6
27. Wang C. C, Karen D. Osteoradionecrosis of the temporal bone—consideration of Nominal Standard Dose. International Journal of Radiation Oncology Biology Physics 1976; 1.9-10: 881-883.

28. Sharon JD, Khwaja SS, Drescher A, Gay H, Chole RA. Osteoradionecrosis of the temporal bone: a case series. Otol Neurotol. 2014 Aug;35(7):1207-17

29. Leonetti JP, Marzo SJ, Zender CA, Porter RG, Melian E. Temporal bone osteoradionecrosis after surgery and radiotherapy for malignant parotid tumors. Otol Neurotol. 2010 Jun;31(4):656-9

30. Morrissey D, Grigg R. Incidence of osteoradionecrosis of the temporal bone. 2011;81: 876-87

Word count: 3390 Tables: – Figures: 4 References: 30

DOI: 10.5604/01.3001.0013.2564 Table of content: https://otorhinolaryngologypl.com/issue/12343

Competing interests: The authors declare that they have no competing interests.

Corresponding author: Anna Rzepakowska, ORCID ID: 0000-0003-4012-8271; Department and Otolaryngology, Medical University of Warsaw, ul. Banacha 1a, 02-097 Warsaw, Poland; Phone no.: +48 225992716; Fax: +48 225992523; E-mail: arzepakowska@wum.edu.pl

Cite this article as: Roszkowski A., Witkowska A., Baranek P., Rzepakowska A., Wnuk E., Niemczyk K.: Rare proliferative and inflammatory pathologies within the temporal bone – a literature review; Pol Otorhino Rev 2019: 8(3): 8-13