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Profile of CT Scans of Petrous Bones at the UHC-Campus of Lomé

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Abstract

Introduction: the purpose of this work was to determine the profile of CT scans of petrous bones, to list the indications, to describe the techniques of realization and the pathological aspects of CT scans observed. **Methods:** this was a prospective and descriptive study carried out over a period of 6 months concerning the CT scans of the petrous bone carried out in the radiology department of the UHC-Campus at Lomé. The parameters studied concerned epidemiological data and lesions observed on computed tomography. **Results**: we had performed 34 CT scans of the petrous bons or 0.5%. Interns, specialty doctors and ENT doctors were the main prescribers

in 58.8% and 32.4% respectively. Patients came more from emergency departments (50%). All age groups were concerned with a predominance of those 21-40 years (23.5%). The male sex was predominant with a sex ratio of 2.1. Drivers were more represented (23.5%). The most frequent indication was petrous bone trauma (44.1%) and road accidents were the leading cause (73.3%). The examination was performed in all cases without injection of the contrast and was pathological in 70.6% mainly in trauma, conductive hearing loss, chronic otitis media, EAC stenosis and pulsatile tinnitus. The main traumatic injury found was extralabyrinthine fractures (91.7%). Incudo-malleus dislocation was the main ossicular lesion found (25 %). The hemotympanum was found in 83.3%. CT was normal (29.4%) in vertigo/tinnitus, mixed deafness, conductive hearing loss/tinnitus, earache and non-traumatic facial paralysis. **Conclusion:** computed tomography remains the first choice examination in the exploration of petrous bone trauma, conductive hearing loss and chronic otitis media. On the other hand, it occupies a limited place in the exploration of vertigo / tinnitus as well as non-traumatic facial paralysis.

Keywords: Computed, tomography, petrous bone, profile, trauma, deafness, Lomé

Introduction

The petrous bone is the lower part of the temporal bone, located on each side of the skull. It resembles a quadrangular pyramid and forms the inner, horizontal portion of the temporal bone. It contains the middle ear (the eardrum and the chain of ossicles) and is traversed by the facial nerve (Le Petit Larousse, 2017). It plays an essential role in hearing and balance in the human body (Prades, 2010). It is the site of a polymorphism of pathologies (infectious, traumatic, tumoral, and malformative), requiring special monitoring. Its complex composition and the multiplicity of neighboring structures make its study difficult using conventional imaging (Grace, 2012). Computed tomography (CT), also called scanography, is defined as a tomographic radiological chain measuring the absorption of an X-ray beam as it passes through an anatomical volume, with matrix reconstruction of a digitized image (Sonhaye, 2017; Masson, 2023). It remains one of the means of sectional imaging playing an essential role in the exploration of petrous bone. In high resolution, it allows the bone study of the different compartments of the ear (Grace, 2012; Ahmed, 2012). Used with injection of iodinated contrast product, it can study vascular and tissue structures (Prades, 2010; Amy, 2018); it is available and accessible. Its limits in otology, better in ENT, are in the exploration of vertigo, balance disorders and non-traumatic facial paralysis (Amy, 2018).

Method

This was a cross-sectional and descriptive study extending over a six-month period from July 1 to December 31, 2022 at the University Hospital Center Campus of Lomé. It has a General Electric (GE) brand scanner, Bright Speed Elite multi-bar model, allowing the acquisition of 16 slices per 0.5-second rotation. This equipment was started up in 2010. The parameters used are called "petrous helix bone" and are: Field: 20 cm; Matrix: 5122; mAs: 220, kV: 140; reconstruction thickness = 0.6 mm; CTDI vol: 96.6 Gy. Imperative immobility was respected. Patients who had undergone CT examination of the rocks other than patients who came for a follow-up examination were included in our study. None of our patients received an injection of iodinated contrast. Data were collected using a pre-established data collection sheet containing the variables studied, and were analyzed and processed using the epi info software version 3.5.3.

Results

Frequency

During this study, we performed 6,328 CT scans, including 34 for CT scans of the petrous bones, for an overall frequency of 0.5%.
The distribution of patients by age group is shown in Figure 1.

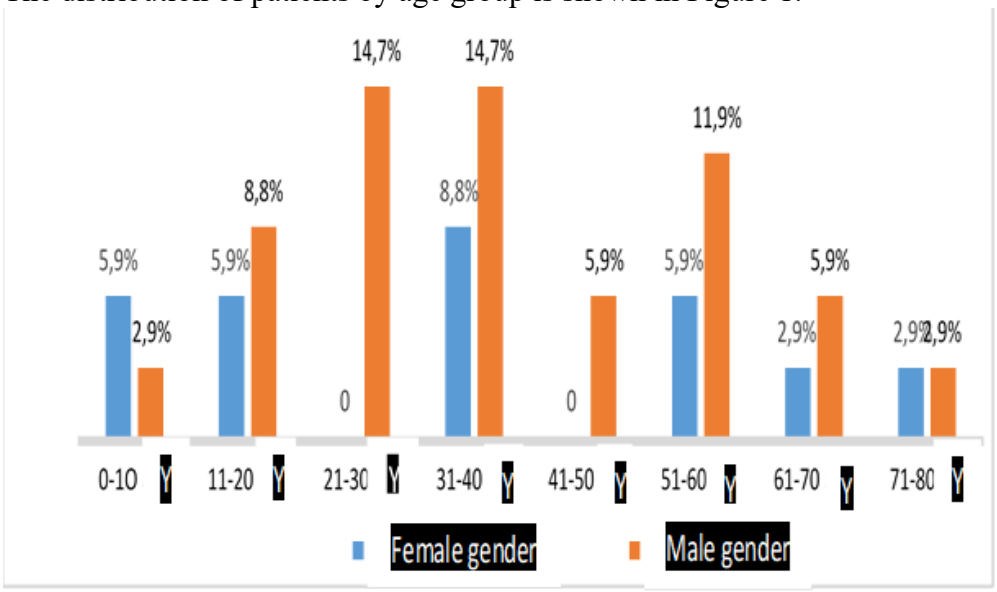

Figure 1: Distribution of patients by age group and gender

In terms of patient profession and occupation, drivers were the most represented, with a proportion of 23.4%.

Table I: Distribution of patients according to the indication for CT of the petrous bones according to the services

	Emergency departments n (%)	ENT departments n (%)	Other departments n (%)	Total n (%)
Trauma	**12(35,3)**	**2(5,9)**	**1(2,9)**	**15(44,1)**
Conductive hearing loss	0(0,0)	5(14,9)	0(0,0)	5(14,9)
EAC stenosis	2(5,9)	2(5,9)	0(0,0)	4(11,8)
Chronic otitis media	2(5,9)	2(5,9)	0(0,0)	4(11,8)
Earache	0(0,0)	0(0,0)	1(2,9)	1(2,9)
Mixed hearing loss	0(0,0)	1(2,9)	0(0,0)	1(2,9)
Sensorineural hearing Loss/Tinnitus	0(0,0)	1(2,9)	0(0,0)	1(2,9)
Pulsatile Tinnitus	0(0,0)	1(2,9)	0(0,0)	1(2,9)
Tinnisitus/Vertigo	0(0,0)	0(0,0)	0(0,0)	1(2,9)
Facial Paralysis/Earache	1(2,9)	0(0,0)	1(2,9)	1(2,9)
Total	**17(50)**	**14(41,3)**	**3(8,7)**	**34(100)**

n (%) = Number (percentage)
EAC*=External auditory Canal
ENT=Otorhinolaryngology
Other services=Other university hospital services, private practices, and clinics

Regarding prescribers, residents or physicians in post-graduate studies were the main prescribers, with 58.8%.

The techniques used for CT examinations of the temporal bones were dominated by cranioencephalic CT (55.8% of the time).

As for the results of CT scans of the temporal bones, 70.6% of the examinations were pathological. The various lesions observed according to the indications are shown in Table III.

Table II: Distribution of patients according to CT scan results of the temporal bones according to the indication

	Normal examination n (%)	Pathological examination n (%)	Total n (%)
Traumatism	**3(8,8)**	**12(35,3)**	**15(44,1)**
Conductive hearing loss	2(5,9)	3(8,8)	5(14,7)
EAC stenosis*	0(0,0)	4(11,8)	4(11,8)
Chronic Otis media	0(0,0)	4(11,8)	4(11,8)
Earache	1(2,9)	0(0,0)	1(2,9)
Mixed hearing loss	1(2,9)	0(0,0)	1(2,9)
Sensorineural hearing Loss/Tinnitus	0(0,0)	1(2,9)	1(2,9)
Pulsatile Tinnitus	1(2,9)	0(0,0)	1(2,9)
Tinnisitus/Vertigo	1(2,9)	0(0,0)	1(2,9)
Facial Paralysis/Earache	1(2,9)	0(0,0)	1(2,9)
Total	**10(29,4)**	**24(70,6)**	**34(100)**

Table III: Traumatic lesions observed

Traumatic injuries	Number (n)	Percentage (%)
Hemotympanum	**10**	**83,3**
Temporal squamous cell fracture	9	75
Mastoid cell filling	8	66,7
Tympanic bone fracture	7	58,3
Mastoid fracture	5	41,7
Ossicular injuries	3	25
Tegmen tympani fracture	1	8,8
Fracture of the inner wall of the middle ear	1	8,8

n (%) = Effective (percentage)

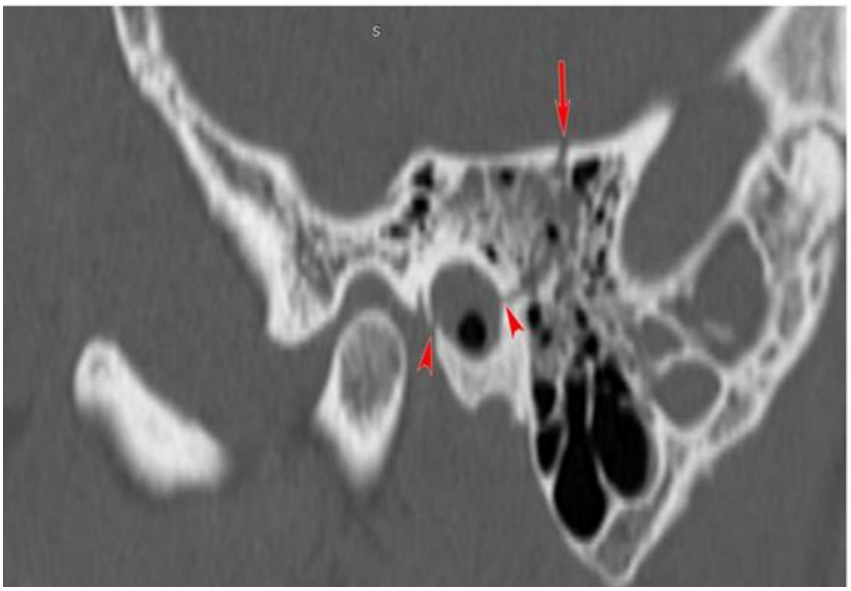

Figure 2: Image from the University Hospital Campus (Lomé)

22-year-old male patient with head trauma and otorrhagia. Sagittal CT reconstruction of the left temporal bone, showing a disruption of the left temporal bone squama, reflecting an extralabyrinthine fracture (arrowhead), associated with filling of the tympanic cavity, reflecting a hemotympanum, and a disruption of the tegmen tympani (arrow).

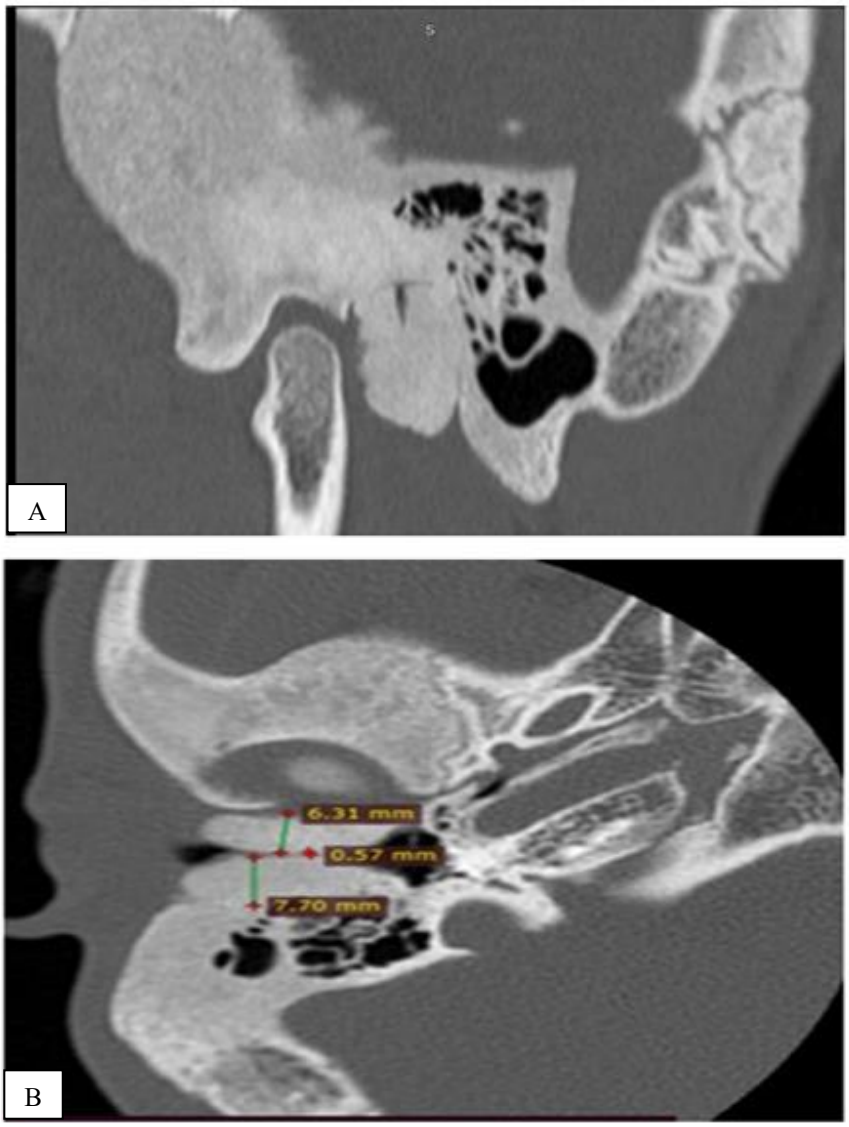

Figure 3a, b: Image from the UHC-Campus (Lomé)

40-year-old male patient with stenosis of the right external auditory canal, showing in sagittal reconstruction (a) and axial section (b) CT of the right petrous bone, a ground-glass appearance of the bone medulla at the level of the bone medulla of the external third of the petrous part of the temporal bone; a blown cortex and thinning of the cortex without bone lysis leading to stenosis of the right external auditory canal.

Discussion

General Characteristics

Frequency and site of CT Examinations of the Petrous Bones

During the study period, 6,328 patients were seen for CT examinations, including 34 for CT examinations of the petrous bones, for an overall frequency of 0.54%. This indicates that the demand for CT examinations of the petrous bones remains low in our setting.

Age and Sex

The mean age was 37 years, with extremes of 1 year and 75 years. A clear predominance of the 21-40 age group (38.2%) was noted, compared to 23.3% in the 0-20 age group. Consistent with the indications for CT examination of the petrous bones (Prades, 2010), all ages were interested in CT examination of the petrous bones, with a predominance in young adults. Males were more represented, with 67.6%, compared to 32.3% for females, with a sex ratio of 2.1. This may be explained by the high frequency of CT examinations of traumatic petrous bones in the study, i.e., 44.1% (Table II). This predominance of young adults in CT examination of traumatic petrous bones has already been noted by Sonhaye et al. (Sonhaye, 2017) who reported 57.7% for the 20-40 age group and the male sex was the most frequent with 77.4% against 22.6% for the female sex, i.e. a male predominance with a sex ratio of 3.42. Similarly, this male predominance has already been reported by Hiroual et al (Hiroual, 2010) in a significant proportion with a sex ratio of 16 men for one woman. The predominance of the male sex both in the literature and in this series could be explained by the fact that trauma is the prerogative of men.

Occupation

Anyone, regardless of their profession, can develop petrous bones injury. Road traffic accidents involving two-wheeled vehicles are the common cause of over 50% of deaths among young adults aged 15 to 44 (WHO, 2015).

In this series, rock injury represented 44.1% of young adults aged 21 to 40. This result is consistent with that of Issa et al. (Issa, 2020), with a proportion of 42.9%. In the 15 CT requests for petrous bones injury, vehicle drivers were the most frequently involved, with a proportion of 53.3%, including 75% of two-wheeled vehicle drivers versus 25% of four-wheeled vehicle drivers. Two-wheeled vehicle drivers were therefore highly exposed to petrous bone injury.

Indications

The main indication for CT of the temporal bones was trauma, with a frequency of 44.1%, followed by conductive hearing loss (14.7%), chronic otitis media (11.8%), and external auditory canal stenosis (11.8%). Earache, mixed hearing loss, sensorineural hearing loss/tinnitus, pulsatile tinnitus, tinnitus/vertigo, and facial paralysis/otalgia each accounted for 2.9%. These results are consistent with data from the literature (Amy, 2018), where CT remains the first-line examination for investigating temporal bone trauma and conductive hearing loss with a normal eardrum. On the other hand, it is often supplemented or replaced by MRI when it comes to exploring facial paralysis, tinnitus and vertigo (Masson, 2013). However, CT is only indicated in chronic otitis media for pre-operative assessment if surgical treatment is envisaged due to significant conductive deafness (WHO, 2015). Similarly, it retains its place for exploring otalgia with positive otoscopy, particularly in necrotizing or complicated external otitis or in exploring otalgia secondary to a tumor of the EAC or the middle ear (Prades, 2010).

Prescribers and Patient Referral Services

CT scans of the temporal bones were requested primarily by residents and specialist physicians who are on-call and on-call, with a frequency of 58.8%, followed by ENT physicians at 32.3%, and prescriptions from other physicians were carried out in 8.8%. Similarly, the surgical emergency department (50% of cases) and ENT departments (41.2% of cases) were the main referral services for CT scans of the temporal bones. These results corroborate data from the literature (Sonhaye, 2017). This could be explained, on the one hand, by the predominance of traumatic temporal bones in this study and the fact that in Lomé, both university hospitals had a surgical emergency department, and only the CT department at the University Hospital Campus was operational. On the other hand, apart from trauma, the main reasons for requesting CT scans of the rocks fall within the ENT specialty (deafness, chronic otitis media, stenosis of the AEM, earache, pulsatile tinnitus, vertigo/tinnitus and facial paralysis/earache).

CT Examination Techniques

The most commonly performed examination technique was cranioencephalic CT followed by a bone helix CT of the petrous bones in 55.9% of cases, primarily in patients referred for CT of the petrous bones in the context of immediate cranioencephalic trauma with suspected petrous bone fracture. The choice of this technique was justified by Saraiya (Saraiya, 2009), who noted the inadequacy of performing a cerebral CT with thin-slice reconstruction in a bone window on the petrous bones. According to him, this technique is responsible for an inaccurate lesion assessment, with nearly

a third of petrous bone fractures going undetected. In addition, for Amy et al (Amy, 2018) 18% to 22% of skull fractures involve the temporal bone and according to Sun et al (Sun, 2011) 90% of patients received for rock trauma have a brain injury, hence the need to supplement cranioencephalic CT with a petrous bones CT in patients received for rock CT in the context of immediate cranioencephalic trauma with suspicion of petrous bone fracture. In this series, performing a CT scan of the petrous bones "helix bone" immediately in 32.3%, mainly in patients received at a distance from the trauma and having already benefited from a cerebral CT scan and other indications besides conductive deafness with suspicion of otosclerosis. This technique allows a better exploration of ossicular lesions due to the resorption of the hemotympanum in the days following the trauma (Amy, 2018) in patients received for conductive deafness with suspicion of otosclerosis. Performing a CT scan of the petrous bones "helix otosclerosis" shows 11.8% in this series. It should be noted that centering involving only an approach to the tympanic cavities, the labyrinthine capsule, and the internal acoustic meatus allows for a "magnifying glass effect" compared to traditional axial slices. All examinations were performed without injection of iodinated contrast. It should be noted that injection of iodinated contrast is indicated in cases of suspected expansive processes or malignant external otitis.

CT Results of Pathological or Normal Petrous Bones

CT results of the petrous bones were pathological in 70.6% and normal in 29.4%. The high rate of pathological examinations was mainly observed among trauma, chronic otitis media, and EAC stenosis. This may be explained by the excellent natural contrast between air and ossicles, making CT exploration of the middle ear easy, and the high sensitivity of CT scanning to detect bone lesions, particularly petrous bone fractures, according to studies by Darrouzet et al. (Darrouzet, 2010).

Traumatic Injuries

Fracture Type

Extralabyrinthine fractures were the most common at 91.7%, followed by a mixed fracture at 8.3%. These results are similar to those reported in the literature (Sonyahe, 2017). According to (Barreau, 2011), extralabyrinthine fractures account for over 90% of petrous fractures, and between 94 and 97% according to Amy et al. (Amy, 2018). However, Traoré et al. (Traoré, 2022) found a proportion of 79.3% in their study.

Associated Lesions

Several lesions were associated with the fractures, primarily hemotympanum at 83.3%, followed by hemorrhagic filling of mastoid cells at 66.7%. These data are lower than those found by Sonhaye et al. (Sonhaye, 2017), with proportions of 96.7% for hemotympanum and 80.3% for hemorrhagic filling of mastoid cells. However, Traoré et al. (Traoré, 2022) found a lower rate than this sample, with proportions of 72.4% for hemotympanum and 55.2% for hemorrhagic filling of mastoid cells. The higher sensitivity of CT in detecting hemotympanum may explain these high rates.

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Lesions Found in Chronic Otitis Media

The four CT scans for chronic otitis media were 100% positive. All patients presented with mastoid and tympanic cavity filling with mastoid cortical osteolysis and/or osteosclerosis; only one patient presented with ossicular erosion. These data have been confirmed by the literature (Amy, 2015; Omadjela, 2020). CT frequently shows mastoid cell filling and sclerosis. Other lesions should be sought to explain possible conductive hearing loss. These include perforation of the tympanic membrane, filling of the middle ear cavities, or post-inflammatory erosion of the ossicles (sequel otitis) (Varoqueux, 2010). Secondary cholesteatoma is a major complication of chronic otitis media (Amy, 2015). It represents one third of chronic otitis media with open eardrums and occurs at any age. At an early stage, it presents on CT as a small, round opacity with convex edges, located in the external attical region or "Prussak space". Erosion of the lower angle of the wall of the occlusal cavity is an important element of the positive diagnosis (Varoqueux, 2010). At a more advanced stage, it can present as a more or less round opacity with convex edges of the middle ear eroding the surrounding bony structures, or in the form of complete opacity of the attic or the box. Finally, it can be evacuated either spontaneously or by the clinician during examination. In these cases, the CT examination can be

almost normal with sometimes the visualization of the stigmata left by the evacuated cholesteatoma (marked enlargement of the external attic with blunt appearance of the tip of the wall of the cavity, destruction of the suprameatic scale, ossicular destruction, dehiscence of the tegmen tympani, etc.) (Varoqueux, 2010). Cholesteatoma of the middle ear is a chronic otitis described as dangerous due to its progressive risks and its potentially serious complications that can be life-threatening. The evolution of cholesteatomas is significantly different between adults and children.

External auditory canal stenosis

External auditory canal stenosis is seen at all ages and with a wide range of etiologies. In this study, 11.76% of CT scans of the temporal bones were requested for external auditory meatus stenosis. All findings were pathological. Among these patients, the first two were infants aged 1 and 2 years, and the other two were aged 39 and 40 years. Three of them had tissue filling of the EAC, or 75%, with other associated or unassociated signs. The first, aged 1 year, had almost total tissue filling of the right external auditory canal and partial tissue filling on the left, associated with bilateral fixation of the ossicles. The second, aged 2 years, presented with almost total tissue filling of the right external acoustic canal. In the third patient, aged 39 years, the examination showed tissue filling of the external acoustic canal with more marked bone erosions on the left. According to the literature (Azedine, 2016), pathologies of the external acoustic canal which can have a similar clinical presentation as well as tissue filling on TMD can point towards several pathologies (epidermal pathologies; cholesteatoma, epidermal cyst, cholesterin granuloma; nervous pathologies, meningioma and schwannoma). Azeddine et al (Azedine, 2016). In the fourth patient aged 40, the examination revealed a ground glass appearance of the bone medulla in the bone medulla of the outer third of the petrous part of the temporal bone; a blown cortex and thinning of the cortex without bone lysis leading to stenosis of the right acoustic meatus secondary to fibrous dysplasia of the temporal bone. These classic CT features have been described in the literature (Mahoudeau, 2022). Fibrous dysplasia is a rare pathology that can affect all bones in the body, particularly those of the face. At the craniofacial level, the maxilla, zygoma, frontal bone, ethmoid and mandible are the most commonly affected bones. Conversely, involvement of the temporal bone is rare and represents only 11 to 12% of craniofacial fibrous dysplasias (Azedine, 2016). CT examination also makes it possible to detect possible stenoses of the foramens of the base of the skull.

Lesions in Conductive Hearing Loss

In this study, conductive hearing loss represented 14.3% of petrous bone CT scans, including a malformation of the ossicular chain with an inverted (downward) appearance of the incudomallear joint. Other forms of minor ossicular chain malformations have been described in the literature. According to the literature, sensorineural hearing loss in children is genetic in 50% of cases and environmental in origin (CMV, neonatal distress, meningitis, etc.). Genetic causes are most often isolated, but can also be part of a syndrome in 30% of cases (Veillon, 2010).

Conclusion

This study shows that CT of the petrous bones is the primary imaging method, but its demand remains low and is mainly made by interns, doctors specializing in surgical emergencies, and ENT doctors. Both sexes were concerned, with a male predominance. The age group of 31-40 years was the most represented. The most frequent indication remains trauma of the rocks, where CT occupies a prominent place, followed by conductive hearing loss, stenosis of the ear canal, and chronic otitis media. However, it occupies a limited place in the exploration of vertigo/tinnitus and non-traumatic facial paralysis. Ear pathology constitutes a public health problem and has a negative impact on interpersonal relationships.

Conflict of Interest: The authors reported no conflict of interest.

Data Availability: All data are included in the content of the paper.

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