Disability in a medieval village community: A unique case of facial dysmorphism

Valentin Miclon, Samuel Bédécarrats, Boris Laure, Elisabeth Zadora-Rio, Matthieu Gaultier, Hélène Coqueugniot, Estelle Herrscher

Disability in a medieval village community: a unique case of facial dysmorphism.

Miclon, Valentin* (UMR CITERES 7324 - LAT; Université de Tours) - Bédécarrats, Samuel* (UMR CITERES 7324 - LAT; Université de Tours) - Laure, Boris (CHRU de Tours - Service de chirurgie maxillo-faciale, Hôpital Trousseau) - Zadora-Rio, Elisabeth (UMR CITERES 7324 - LAT; Université de Tours) - Gaultier, Matthieu (SADIL; UMR CITERES 7324 - LAT) - Coqueugniot, Hélène (UMR 5199 PACEA; Université de Bordeaux; Ecole Pratique des Hautes Etudes – EPHE-PSL) - Herrscher, Estelle (UMR 7269 LAMPEA, Aix Marseille Univ, CNRS, Minist Culture).

* These authors contributed equally to this work

Corresponding author: Valentin Miclon (valentin.miclon@gmail.com ; UMR CITERES 7324 – LAT, 35 Allée Ferdinand de Lesseps, 37200 Tours).

Abstract

Objective

To identify the pathology causing the severe facial dysmorphia of a medieval individual from the site of Rigny (Indre-et-Loire, France) and to evaluate its functional repercussions on the subject's hearing and social life.

Materials

One individual from Rigny for the osteological study, 69 individuals from the region for the Ct-Scan study and 48 individuals from the site for the isotopic analysis.

Methods

Macroscopic analysis was performed using standard osteological methods. Consequences of pathology on hearing were assessed by CT-scan. Dietary behaviour was analysed by stable carbon and nitrogen isotope analysis of bone collagen.

Results

The individual is a woman who was over 50 years of age at the time of her death with a severe form of Treacher-Collins syndrome that resulted in deafness. No osteological signs of maltreatment were observed and there is no evidence that this individual's diet was different from that of the rest of the community.

Conclusions

All information testifies to the full integration of this individual into the village population.

Significance

This study is the first archaeological description of Treacher Collins syndrome. It shows the ability of the paleopathological approach to help identify the attitudes of societies for which written sources are most often lacking.

Limitations

In the absence of palaeogenomic analysis it is not possible to identify the origin of this case.

Suggestions for further research

Increase the paleopathological semiology by CT-scan in order to specify the consequences of pathologies and integrate isotopic analyses to enrich discussion about perceptions of disease.

Keywords

CT-scan; Isotopes; Deafness; Treacher-Collins syndrome; Care

1. Introduction

Skeletal indicators suggesting an individual lived with the impacts of severe pathology allow for an inference of care in the archaeological record (Tilley, 2015). The organisation of health-related care is a direct result of the social structures and scientific conceptions of the period (Velle, 1998). In the Middle Ages, a particular disease or injury could, paradoxically, be perceived as the result of either religious piety or sin (Agrimi and Crisciani, 1995). The use of modern anthropological techniques in describing pathological cases from this time can assist our reflection on contemporary perceptions of disease.

It is in this framework that the study of a particular individual dated from the Later Medieval period and recovered from the cemetery of the former parish church of Notre-Dame of Rigny (France) was carried out. This site is located in the Région Centre-Val de Loire, in the department of Indre-et-Loire, about thirty kilometres south-west of the city of Tours (Fig. 1).

The excavation around the church of Rigny was carried out under the direction of Elisabeth Zadora-Rio and Henri Galinié, from 1986 to 1999 on a total surface area of about 1200 m2. It uncovered, under the parish cemetery, vast stone buildings from the 7th and 8th centuries, and it revealed the existence of two churches prior to the current church, the oldest parts of which date from the second half of the 11th century. It also made it possible to reconstruct the stages of formation of the parochial cemetery and the fluctuations of its boundaries from the middle of the 8th century until 1865, when it was relocated to a neighbouring village. 1738 burials, dating from the middle of the 8th to the middle of the 19th century were excavated (Zadora-Rio et al., 2020).

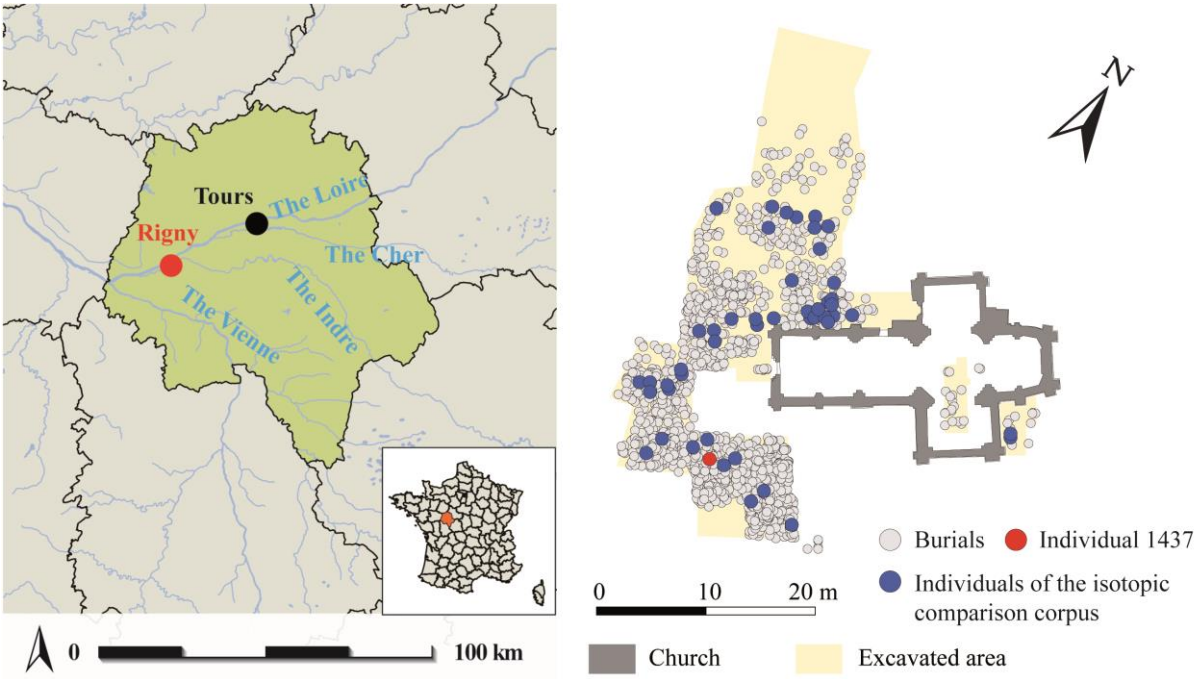

Figure 1: Location of Rigny and position of the grave of Individual 1437 in the excavated areas (credit: UMR CITERES 7324 – LAT).

Of the burials uncovered, Burial 1437 is an individual buried with care, possibly in a shroud, and with their head propped up by two stones (Fig. 1, Fig. 2). This type of head pillow made of stones was fairly common in medieval graves (Boddington et al., 1996). In Rigny, 65 burials of this type were excavated. Most of them are dated before 1100, but Burial 1437 belongs to a small group which date from the 12th century or later (Zadora-Rio et al., 2020). In the first osteological study of the population, this individual was identified as having a set of morphological disorders significantly affecting the face and acoustic meatus (Theureau, 2007). In addition to severe dysmorphia, an alteration of hearing could, therefore, be suspected.

The aim of this study is not only to identify the etiology of this severe facial dysmorphia, but also to analyse its consequences on the hearing of this individual and to evaluate its social repercussions.

The analysis of its social consequences can be carried out by comparing the food practices of this individual with those of the rest of society. Indeed, in the medieval period, diet is particularly diversified and was symbolically charged, in addition to having its essential physiological function. The divisions of society are clearly reflected in the food consumed (Audoin-Rouzeau and Sabban, 2007; Flandrin and Montanari, 1996; Laurioux, 2002; Ravoire and Dietrich, 2009). Diet was also seen as one of the factors that can regulate physiology and had prophylactic and even curative purposes. With this perspective in mind, it was appropriate for each person to take into account the quality and quantity of his or her food, the need to consume specific foods, as well as his or her own health status (Audoin-Rouzeau and Sabban, 2007; Laurioux, 2011, p. 75; Salvat, 1984). This is why the hypothesis of a

specific diet for this individual, as compared to the rest of the population, whether from a perspective of care or exclusion, was offered.

Figure 2: View of the burial of Individual 1437 during excavations (credit: UMR CITERES 7324 – LAT).

Over the past 40 years or so, the analysis of stable isotope ratios of carbon and nitrogen in bone collagen has proven its ability to provide information about the protein portion of the diet and the environment in which food was produced during the last years of the lives of the individuals studied. Over the last twenty years, isotope analyses of the medieval diet have been performed throughout Europe. For this period, in addition to the quasi-systematic search for possible dietary distinctions according to the sex and age of the subjects within the populations studied, these analyses have proven their ability to address various issues. These include determining the age at weaning (Herrscher, 2003; Richards et al., 2002); the evolution of food practices of rural and urban populations facing major social, economic and political changes (Müldner and Richards, 2007a; Reitsema et al., 2017) and the identification of distinct dietary practices of Christians and Muslims (Alexander et al., 2015), of lay people belonging to different social groups in the same city (Kjellström et al., 2009), and of lay and monastic populations buried in different sites (Müldner and Richards, 2005; Polet and

Katzenberg, 2002; Yoder, 2010), or within the same site but in separate burial spaces (Colleter et al., 2019; Müldner and Richards, 2007b; Yoder, 2012).

Because analyses of stable isotope ratios of carbon and nitrogen can identify distinct dietary behaviours in medieval society, we chose to apply this approach to a selected sample from the Rigny site, including Individual 1437, to compare their dietary behaviour with that of the rest of the rural community.

2. Material and methods

Individual 1437, which was in a good state of preservation, underwent a macroscopic osteological re-examination of its entire skeleton in order to identify its sex and estimate its age. The osteological analysis also allowed us to identify the manifestations of dysmorphia and other pathological conditions.

Indeed, although the entire population of this site was the subject of an osteological study in 2007 (see Theureau, 2007), the sex identifications and age estimates proposed then did not result from the application of methods now considered reliable. Therefore, a new osteological examination of Individual 1437 was carried out. Sex estimation was based on probabilistic sex diagnosis (Murail et al., 2005). A probability threshold of 0.95 was required for validation of the diagnosis. Its age-at-death estimation was made by studying the morphology of the auricular surface of the ilium (Schmitt, 2005).

The anatomy of the ears of Individual 1437 was compared to those of a regional sample of 68 individuals free of macroscopic manifestations of dysmorphia from 4 regional medieval sites. The extension of the comparison sample to the region aimed to avoid analytical biases related to possible genetic and/or environmental factors by maximising the variability of normal ear anatomy in medieval Touraine. The comparison sample is composed of 68 individuals, including 29 from Saint-Cosme (Dufaÿ et al., 2018), 18 from Rigny (Zadora-Rio et al., 2020), 13 from Saint-Pierre-le-Puellier (Theureau, 1985) and 8 from Saint-Mexme de Chinon (Lorans, 2006). The 68 individuals of this regional sample were also studied for age and sex determination using probabilistic sex diagnosis (Murail et al., 2005) and the morphology of the auricular surface of the ilium (Schmitt, 2005).

CT-Scan examination of the ear anatomy of all individuals was conducted based on acquisitions made by CIRE platform of the Inra Centre-Val-de-Loire/CHRU of Tours, with a Siemens Somatom Definition AS + scanner with a current of 140 kVp, an exposure of 400 mAs and a section thickness of 0.4 mm. The reconstruction matrix is 512 × 512 × 1491 pixels.

In addition to cross-sectional observations, three-dimensional models of the bones and virtual casts of some internal structures were made. The TIVMI software (Treatment and Increased Vision for Medical Imaging; Dutailly et al., 2009) was used to perform the segmentations and produce the 3D surfaces with its integration of the half maximum height algorithm (HMH; Spoor et al., 1993), which recalculates the segmentation boundaries to

produce models very close to the reality of the reconstructed objects. This software allows a precise positioning of the landmarks and reproducible measurements (Guyomarc'h et al., 2012). The diameter of the internal acoustic meatus was measured at the junction with the tympanic cavity.

The analysis of stable isotope ratios of carbon and nitrogen was conducted on a total of 48 individuals whose age and sex were identified using the same methods as described above (Murail et al., 2005; Schmitt, 2005). Collagen extraction was carried out at the EA 7502 SIMBA in Tours. The protocol used was defined by Longin (1971) and modified by Bocherens et al. (1991). Elemental and isotopic measurements of collagen samples were performed on an isotopic mass spectrometer at the Iso-Analytical laboratory (Crewe, Cheshire, UK). The equipment used was a Europa Scientific 20-20 isotope mass spectrometer coupled with an automated elemental analyser. An internal beef liver standard (IA-R042) was used for which the isotopic content was calibrated from standards provided by the international atomic energy agency: IAEA-CH-6 (sucrose, δ^{13}CV C = −10.43‰) and IAEA-N-1 (ammonium sulfate, δ^{15}N = 0.40‰). The analytical accuracy obtained from the repeated analysis of the internal laboratory standard was less than 0.1‰ for the δ^{13}C and δ^{15}N values.

3. Results

Figure 3: Osteological features of the skull of Individual 1437 (A) Right anterolateral view; B) Atresia of the left acoustic meatus; C) Mandible in right lateral view; credit: Valentin Miclon).

Individual 1437 was identified as a woman (Murail et al., 2005), at least fifty years old at the time of her death (Schmitt, 2005). Her skull displays serious morphological anomalies: specifically, mandibulo-facial dysostosis with bilateral and symmetrical hypoplasia of the zygomatic bones (Fig. 3). The lower margins of the orbits are incomplete and infraorbital foramina are absent. The mandible, and more particularly its branches, is also hypoplastic,

and the mandibular body has a concavity on the inferior surface. The gonial angle appears more obtuse than normal and the condylar neck is short. The temporal bones are also marked by non-fusion of the zygomatic arches and atresia of the external acoustic meatus. None of these lesions are related to a taphonomic or anthropogenic origin (Verano, 2016).

In addition to the severe bilateral expression of this hypoplasia, characterized by the absence of the normal zygoma components and buttresses, no limb abnormalities are observable. The appendicular skeleton, which is well represented, shows only lesions related to senescence and/or biomechanical stress (osteoarthritis, enthesopathy and Schmorl's nodes).

CT examination of Individual 1437 reveals bilateral hypoplasia of the individual's acoustic meatus: its diameter is 2.22 mm on the right and 0.71 mm on the left (Fig. 4). Within the reference sample, the diameters of the right ears (n = 65) ranged from 4.01 to 11.26 mm and measurements of the left ears (n = 62) range from 3.76 to 11.11 mm (see Supplemental Table 1). Compared to the variability in medieval Touraine populations, the measurements obtained for Individual 1437 are very low (Fig. 5).

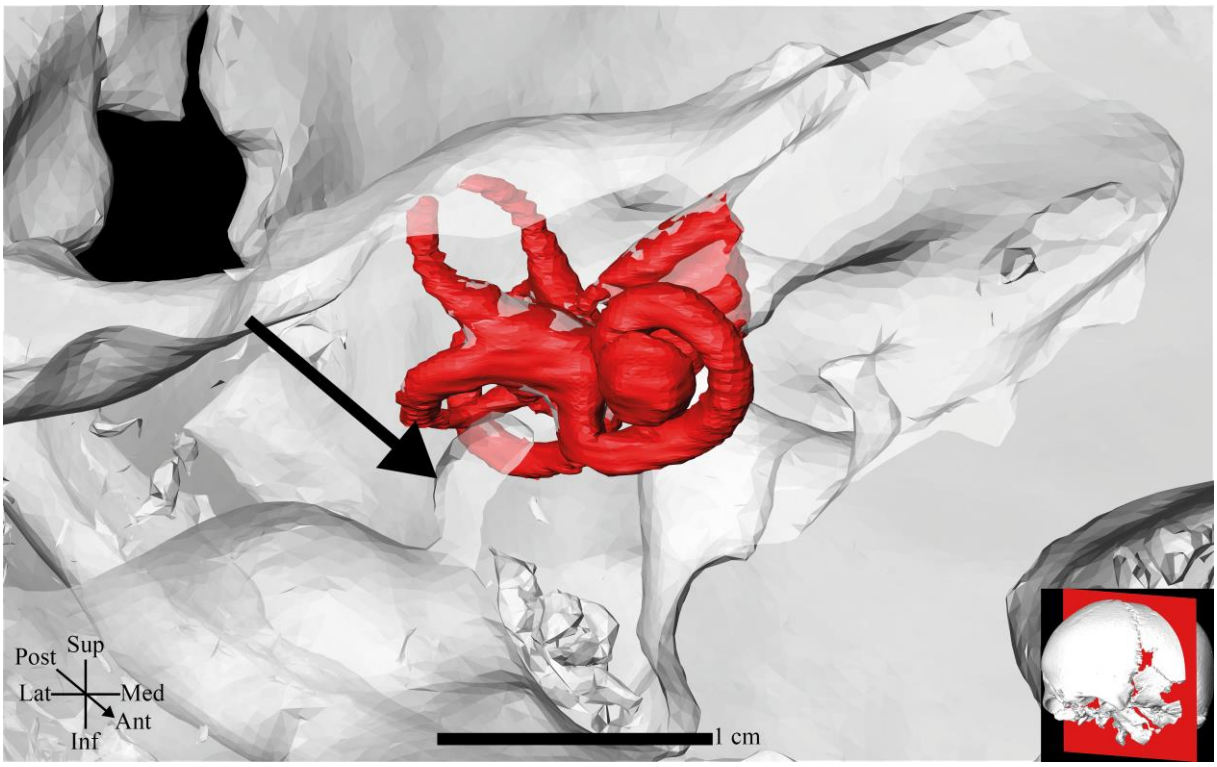

Figure 4: 3D reconstruction of the skull of Individual 1437, cross section at the right ear; Red: osseous labyrinth cast; Arrow: acoustic meatus (credit: Samuel Bédécarrats).

Hypoplasia of this individual's internal acoustic meatus are accompanied by agenesis of the tympanic cavities. The development of the ossicles is incompatible with this agenesis. Three-dimensional modeling of the bone labyrinth also shows an absence of the oval window on

both cochleae. The rest of the bony labyrinth (cochlea and semicircular canals) appears normal.

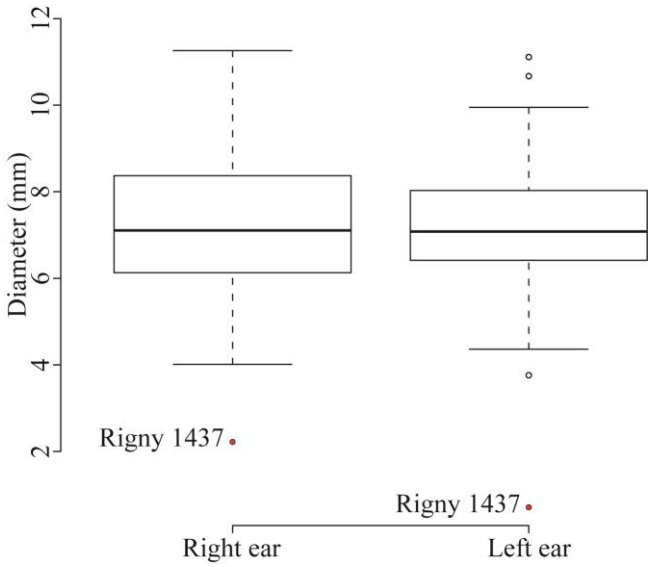

Figure 5: Variability of the diameter of the acoustic meatus in medieval populations from Touraine, France (n=69) (credit: Samuel Bédécarrats).

The samples taken from this individual and 47 others from the Rigny site present collagen conservation indicators in accordance with the classically accepted thresholds (extraction yield > 10 mg/g, %C > 30, %N > 11 and C/N between 2.9 and 3.6; Ambrose, 1990; DeNiro, 1985; van Klinken, 1999).

The isotope ratios of the Rigny population are on average 11.8‰ for $\delta^{15}N$ (n = 48) and of -20.1‰ for $\delta^{13}C$ (n = 48). Ratios derived from Individual 1437 are $\delta^{15}N$ = 12.0‰ and $\delta^{13}C$ = -20.1‰. This individual thus occupies a central isotopic signature within Rigny's isotopic variability (Fig. 6, Supplemental Table 2).

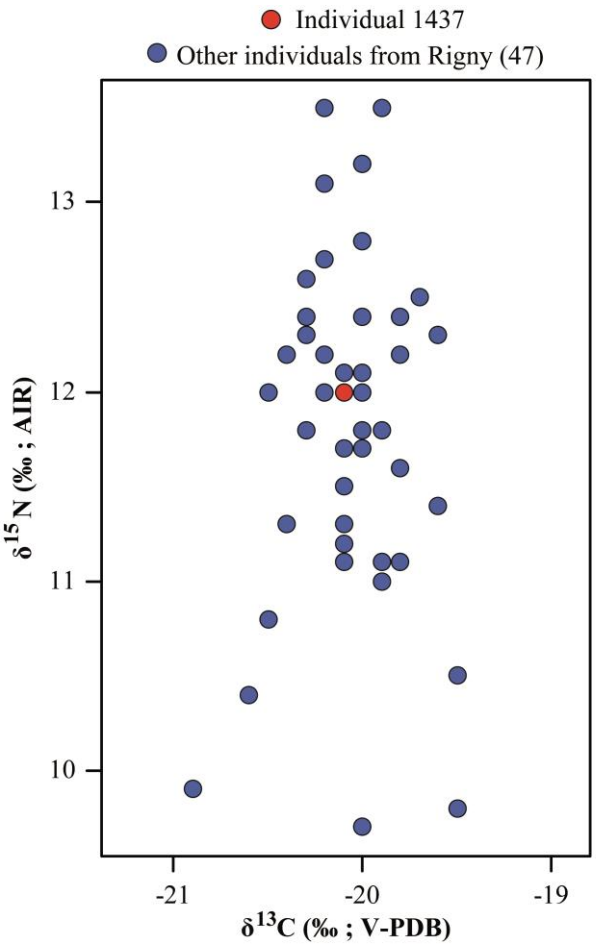

Figure 6: Isotope ratios ($\delta^{15}N$ and $\delta^{13}C$) of individuals from Notre-Dame of Rigny parish cemetery (credit: Valentin Miclon).

4. Discussion

The identification of the etiology of the mandibulofacial dysostosis affecting Individual 1437 is facilitated by the bilateral nature of the hypoplasias, as well as the very good preservation of the infra-cranial skeleton, free of any abnormality. All the skeletal features of this individual allow for the identification of Treacher Collins syndrome, while excluding other disorders with mandibulofacial dysostosis (Table 1). Furthermore, in the absence of the normal components and buttresses of the zygomas, the severity of zygomatic hypoplasia associated with Treacher Collins syndrome is strong for Individual 1437 (Chang and Steinbacher, 2012).

Table 1: Main skeletal characteristics of Individual 1437 in relation to those of the main disorders with mandibulofacial dysostosis, according to the criteria by Kabak et al., 2019; Katsanis and Jabs, 2020; Lines et al., 2020; Vincent et al., 2016. Skeletal features: - not consistent with; + occasionally observed; ++ highly consistent with.

	Cranial abnormalities					**infracranial abnormalities**
	Hypoplasia of the maxilla and zygoma	**Hypoplasia of the mandible**	**Atresia of the external acoustic meatus**	**Symmetrical facial abnormalities**	**Cleft palate**	
Individual 1437	Yes	Yes	Yes	Yes	No	No
Treacher Collins syndrome	++	++	++	++	+	-
Mandibulofacial dysostosis with microcephaly (OMIM 610536)	+	++	+	-	+	Thumbs abnormalities, short stature, spine abnormalities
Nager syndrome (OMIM 154400)	++	++	+	++	++	Limb deformities, preaxial abnormalities (e.g. small or absent thumbs, triphalangeal thumbs, radial hypoplasia or aplasia, radioulnar synostosis, metatarsus varus, talipes with hypoplasia of the metatarsals, and large and short halluces)
Miller syndrome (OMIM 263750)	++	++	+	++	++	Limb deformities, postaxial abnormalities (e.g. small or absent 5th digit incl 5th metacarpal, ulnar hypoplasia, absent 5th toe)
Hemifacial microsomia, Goldenhar syndrome, Oculoauriculovertebral spectrum (OMIM 164210)	+	++	-	-	++	Abnormalities of the ribs and vertebrae, Kippel-Feil syndrome
Nonsyndromic mandibular hypoplasia	-	++	-	+	-	-

Treacher Collins syndrome (also known as Franceschetti-Zwahlen-Klein syndrome) is a rare congenital craniofacial disorder. Its incidence is estimated at one live birth in fifty thousand (Gorlin et al., 2001). To our knowledge, it has never before been identified in the archaeological record.

The range of expression of this syndrome is wide, ranging from mild cases without functional deficit and with minimal deformity, to severe cases in which death may occur during the perinatal period due to airway involvement. Facial dysmorphia, characteristic of this syndrome, includes a narrow face, obliquity down and out of the palpebral fissure, coloboma of the lower eyelids, depressed cheekbones, malformed earlobes, dental malocclusion, receding chin, and mouth turned down (Fazen et al., 1967; Gorlin et al., 2001; Lalauze-Pol, 2020; Marres et al., 1995; Posnick and Ruiz, 2000; Trainor et al., 2009).

In more than 90 % of cases, this syndrome is associated with mutations in the TCOF1 gene, identified on chromosome 5 (5q32), which are transmitted in the autosomal dominant mode (The Treacher Collins Syndrome Collaborative Group et al., 1996). Since no paleogenomic study has been conducted on this individual, it is impossible to determine the presence of the mutation.

CT-scan examination demonstrated the absence or hypoplasia of the acoustic meatus, tympanic cavity, ossicles and oval window. This individual must therefore have suffered from a physiological inability to perceive sounds as a result of bilateral conductive deafness, as has been observed in modern cases of Treacher-Collins syndrome with similar dysplasia (Phelps et al., 1981; Sando et al., 1984).

Physicians from antiquity and the Middle Ages recognized deafness as a disease. If the condition was congenital, theologians associated it with muteness, and it was considered incurable or only addressed by religiomagical practices (Metzler, 2006). The direct account given by Theresa of Carthagena, a Spanish nun who lived in the 15th century and suffered from deafness, further reveals the psychological consequences and sense of isolation associated with hearing loss at that time (Hsy, 2016). In her text, Theresa of Carthagena sought relief through religious life. Religious institutions seem to have been propitious to the social integration of deaf people, as the appearance of communities that took a vow of silence was accompanied by the first codifications of communication by sign (Bruce, 2005).

In the case of Individual 1437 from Rigny, the psychological and intimate repercussions of illnesses are impossible to appreciate given the absence of narrative texts. However, a case of such marked dysplasia, which was likely regarded as a ‘monstrosity’ attributable to sin (Pentassuglia, 2011), was potentially associated with a strong social stigma and the experience of deformity, deafness, and possible mutism, which suggests a very high risk of social segregation.

However, Individual 1437 was a woman who lived for at least fifty years and for whom no lesions attributable to mistreatment were observed. Moreover, her diet, as well as the burial

practices bestowed upon her, do not differ from those of the rest of the community, suggesting that she was integrated into the population of this village and accorded of a form of care by the community.

5. Conclusion

The osteological study of Individual 1437 from the Rigny churchyard identified a woman over fifty years of age at the time of her death with Treacher Collins syndrome. The CT scan examination identified conductive deafness as a consequence of craniofacial dysplasia. Taking into account the medieval historical context, it can be assumed that there was a high risk of social exclusion of this individual because of her deformity, deafness, and her probable mutism. However, the information gathered, both osteological and archaeological, seems inconsistent with this hypothesis and suggests the full integration of this individual into the village population.

This case, apart from being the first description of Treacher Collins syndrome in an archaeological context, highlights the ability of paleopathology to help identify the attitudes of rural societies for which written sources are usually lacking. The discovery of pathological cases requiring care in a parish context is not new, but is mostly limited to isolated cases (e.g., Burrell et al., 2019; Hoffman et al., 2019; Stirland, 1997). It is therefore important to systematically increase the paleopathological semiology by CT acquisitions in order to identify the consequences of pathologies. Since eating behaviour is a social marker for most societies in the past, it is also important to integrate isotopic analysis into research in order to enrich discussions on perceptions of disease within contemporary culture.

Supplementary material

Supplemental Table 1. Measurements of external auditory canal diameters and osteological and contextual data of 69 individuals from Touraine.

Site	Individual	Context	Period	Age	Sex	Diameter (mm)	
						Right ear	Left ear
St. Cosme (La Riche)	44	Priory	13^{th}-15^{th}	>40	M	10.84	10.67
St. Cosme (La Riche)	51	Priory	10^{th}-12^{th}	20-59	M	7.09	9.73
St. Cosme (La Riche)	364	Priory	10^{th}-12^{th}	20-39	M	8.61	8.68
St. Cosme (La Riche)	416	Priory	13^{th}-15^{th}	20-39	I	8.46	7.56
St. Cosme (La Riche)	432	Priory	10^{th}-12^{th}	>50	M	7.02	7.00
St. Cosme (La Riche)	441	Priory	13^{th}-15^{th}	>30	F	6.65	6.41
St. Cosme (La Riche)	443	Priory	13^{th}-15^{th}	>40	M	4.83	7.64
St. Cosme (La Riche)	466	Priory	10^{th}-12^{th}	20-39	M	5.15	7.90
St. Cosme (La Riche)	469	Priory	10^{th}-12^{th}	20-59	M	7.35	5.58
St. Cosme (La Riche)	511	Priory	10^{th}-12^{th}	>20	M	4.79	7.63
St. Cosme (La Riche)	533	Priory	13^{th}-15^{th}	>40	M	6.94	5.69
St. Cosme (La Riche)	556	Priory	13^{th}-15^{th}	10-19	M	10.56	6.63
St. Cosme (La Riche)	566	Priory	13^{th}-15^{th}	>40	M	7.39	7.69
St. Cosme (La Riche)	572_1	Priory	13^{th}-15^{th}	20-39	M	8.58	6.52
St. Cosme (La Riche)	572_3	Priory	13^{th}-15^{th}	20-59	M	8.83	7.47
St. Cosme (La Riche)	587	Priory	13^{th}-15^{th}	>40	F	-	5.71
St. Cosme (La Riche)	596_1	Priory	13^{th}-15^{th}	>40	M	4.01	5.51

St. Cosme (La Riche)	596_2	Priory	13th-15th	20-49	M	6.13	-
St. Cosme (La Riche)	802	Priory	13th-15th	20-59	M	7.00	7.08
St. Cosme (La Riche)	818	Priory	13th-15th	>50	M	8.77	-
St. Cosme (La Riche)	834	Priory	10th-12th	>40	M	4.68	4.42
St. Cosme (La Riche)	845	Priory	13th-15th	>40	M	7.26	8.20
St. Cosme (La Riche)	850	Priory	13th-15th	>50	M	6.09	7.54
St. Cosme (La Riche)	861	Priory	10th-12th	>50	M	8.73	-
St. Cosme (La Riche)	882	Priory	10th-12th	>40	M	7.40	8.51
St. Cosme (La Riche)	924	Priory	10th-12th	>30	M	6.38	6.22
St. Cosme (La Riche)	942	Priory	10th-12th	>20	I	5.68	8.41
St. Cosme (La Riche)	946	Priory	13th-15th	>40	M	-	6.82
St. Cosme (La Riche)	1003	Priory	10th-12th	>30	F	7.06	6.90
Rigny	41	Rural Parish	13th-15th	20-39	F	-	7.67
Rigny	58	Rural Parish	13th-15th	20-39	F	5.44	5.27
Rigny	62	Rural Parish	10th-12th	20-59	M	6.55	5.97
Rigny	79	Rural Parish	13th-15th	>50	F	10.13	8.22
Rigny	85	Rural Parish	10th-12th	20-59	F	6.58	7.98
Rigny	86	Rural Parish	10th-12th	20-39	M	9.14	8.15
Rigny	97	Rural Parish	13th-15th	>50	I	6.47	7.18
Rigny	550	Rural Parish	10th-12th	20-39	F	7.36	4.36
Rigny	586	Rural Parish	10th-12th	>30	M	7.12	-
Rigny	1361	Rural Parish	10th-15th	>50	M	7.12	6.50
Rigny	1435	Rural Parish	10th-15th	20-59	M	6.85	6.42
Rigny	1437	Rural Parish	10th-15th	>50	F	2.22	0.71
Rigny	1488	Rural Parish	10th-15th	20-39	F	8.13	9.95
Rigny	1521	Rural Parish	10th-15th	>20	I	6.12	6.97
Rigny	1582	Rural Parish	13th-15th	20-39	M	6.52	-
Rigny	1721	Rural Parish	10th-15th	20-59	M	8.67	8.57
Rigny	1935	Rural Parish	10th-15th	20-39	F	6.76	7.60
Rigny	2001	Rural Parish	10th-15th	20-39	F	7.89	7.95
Rigny	2120	Rural Parish	10th-15th	20-39	M	5.92	6.49
St. Mexme (Chinon)	98	Urban Parish	13th-15th	>40	M	7.60	6.10
St. Mexme (Chinon)	103	Urban Parish	13th-15th	>30	M	7.97	6.73
St. Mexme (Chinon)	105	Urban Parish	13th-15th	>40	M	5.65	6.57
St. Mexme (Chinon)	145	Urban Parish	13th-15th	>20	I	9.38	11.11
St. Mexme (Chinon)	147	Urban Parish	13th-15th	>30	M	9.82	7.54
St. Mexme (Chinon)	151	Urban Parish	13th-15th	20-59	M	8.43	8.08
St. Mexme (Chinon)	486	Urban Parish	13th-15th	>40	I	7.84	8.71
St. Mexme (Chinon)	538	Urban Parish	13th-15th	>20	I	5.92	5.85
St. Pierre-le-Puellier (Tours)	188	Urban Parish	13th-15th	>40	I	11.26	7.17
St. Pierre-le-Puellier (Tours)	189	Urban Parish	13th-15th	20-59	F	6.57	7.00
St. Pierre-le-Puellier (Tours)	232	Urban Parish	10th-12th	20-49	F	7.79	7.73
St. Pierre-le-Puellier (Tours)	241	Urban Parish	13th-15th	20-39	F	7.71	8.20
St. Pierre-le-Puellier (Tours)	245	Urban Parish	10th-12th	20-49	M	6.74	8.24
St. Pierre-le-Puellier (Tours)	246	Urban Parish	10th-12th	>50	F	5.14	6.70
St. Pierre-le-Puellier (Tours)	260	Urban Parish	10th-12th	20-59	F	8.37	6.80
St. Pierre-le-Puellier (Tours)	271	Urban Parish	10th-12th	>40	F	7.85	-
St. Pierre-le-Puellier (Tours)	275	Urban Parish	10th-12th	>20	I	9.59	6.80
St. Pierre-le-Puellier (Tours)	287	Urban Parish	10th-12th	20-59	I	8.18	9.04
St. Pierre-le-Puellier (Tours)	308	Urban Parish	10th-12th	>20	I	5.74	5.33
St. Pierre-le-Puellier (Tours)	314	Urban Parish	10th-12th	>50	M	6.64	5.43
St. Pierre-le-Puellier (Tours)	347	Urban Parish	10th-12th	20-29	F	5.27	3.76

Supplemental Table 2: Osteological, chronological and biogeochemical data of 48 individuals from Rigny.

Individual	Period	Age (90%)	Sex	Bone	Yield (mg/g)	%C	%N	C/N	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)
12	13th-15th	20-59	F	Pha prox hand	59.9	39.9	15.0	3.1	-20.2	12.0
15	13th-15th	20-59	F	Pha prox hand	49.3	40.3	15.0	3.1	-20.1	11.7
41	13th-15th	20-39	F	Pha prox hand	138.8	43.0	16.1	3.1	-19.9	11.0
48	13th-15th	20-39	F	Pha prox hand	150.7	43.9	16.6	3.1	-20.1	12.1
51	13th-15th	20-59	H	Pha prox hand	115.1	43.9	16.4	3.1	-19.8	12.4
53	13th-15th	>40	F	Pha prox hand	67.6	40.0	14.9	3.1	-19.6	12.3
54	13th-15th	>30	I	Pha prox hand	110.3	42.3	16.0	3.1	-20.2	12.7
58	13th-15th	20-39	F	Pha prox hand	118.7	43.1	16.1	3.1	-20.2	13.1
62	10th-12th	20-59	H	Pha prox hand	121.2	41.5	15.6	3.1	-19.6	11.4
72	13th-15th	>40	H	Pha prox hand	132.8	41.2	15.3	3.1	-19.9	13.5
79	13th-15th	>50	F	Pha prox hand	72.6	43.1	16.1	3.1	-19.7	12.5
85	10th-12th	20-59	F	Pha prox hand	203.3	41.5	15.8	3.1	-20.3	12.4
86	10th-12th	20-39	H	Pha prox hand	114.5	41.7	15.6	3.1	-20.0	13.2
88	10th-12th	20-39	F	Pha prox hand	140.8	43.1	16.3	3.1	-20.3	12.6
97	13th-15th	>50	I	Pha prox hand	116.7	39.6	14.8	3.1	-20.1	11.2
460	10th-15th	20-39	I	R MTT 3	96.6	40.0	15.0	3.1	-20.1	11.5
461	10th-15th	20-59	I	Pha prox hand	158.4	43.5	16.4	3.1	-20.2	13.5
545	10th-12th	20-39	H	Pha prox hand	54.1	42.8	15.9	3.1	-19.9	11.8
550	10th-12th	20-39	F	Pha prox hand	55.9	41.5	15.3	3.2	-20.6	10.4
560	10th-12th	20-39	F	Pha prox hand	104.2	41.0	15.5	3.1	-20.0	9.7
567	10th-12th	20-59	I	Pha prox hand	190.5	44.1	16.3	3.2	-20.5	10.8
571	10th-12th	20-59	H	R MTC 2	31.5	41.2	15.0	3.2	-20.2	12.0
577	10th-12th	20-39	F	Pha prox hand	53.6	43.0	15.8	3.2	-20.0	12.0
586	10th-12th	>30	H	Pha prox hand	91.6	40.4	15.1	3.1	-20.1	11.7
603	10th-12th	20-39	H	Pha prox hand	160.9	42.8	16.0	3.1	-20.1	11.3
606	10th-12th	20-39	H	Pha prox hand	121.9	41.2	15.4	3.1	-20.3	11.8
768	10th-12th	20-59	H	Pha prox hand	133.2	42.1	15.8	3.1	-19.9	11.1
1283	10th-15th	>20	I	L Radius	94.8	39.7	14.8	3.1	-20.4	12.2
1346	10th-15th	20-39	F	Pha prox hand	53.5	41.3	15.5	3.1	-20.0	12.4
1361	10th-15th	>50	H	L MTC 2	158.4	41.8	15.9	3.1	-19.5	10.5
1364	10th-15th	>40	H	Pha prox hand	151.1	43.5	16.1	3.1	-20.3	11.8
1406	10th-15th	>20	I	Pha prox hand	123.9	44.6	16.3	3.2	-20.9	9.9
1420	10th-15th	>20	I	Pha prox hand	92.7	43.0	15.9	3.1	-20.5	12.0
1435	10th-15th	20-59	H	Pha prox hand	188.3	43.4	16.2	3.1	-20.1	11.3
1437	10th-15th	>50	F	Pha prox hand	150.8	41.8	15.7	3.1	-20.1	12.0
1488	10th-15th	20-39	F	R MTC 2	79.1	44.1	16.2	3.2	-20.2	13.1
1497	10th-15th	>30	H	R MTT 5	112.0	38.9	14.6	3.1	-20.0	12.1
1521	10th-15th	>20	I	L MTC 4	181.1	44.7	16.6	3.1	-20.0	11.8
1582	13th-15th	20-39	H	Pha prox hand	144.2	43.0	16.2	3.1	-20.0	12.8
1715	10th-15th	>40	H	Pha prox hand	33.1	40.7	15.1	3.1	-20.2	12.2
1721	10th-15th	20-59	H	Pha prox hand	150.6	45.0	17.0	3.1	-19.8	12.2
1905	10th-15th	20-59	H	R MTT 5	116.4	43.3	16.2	3.1	-19.5	9.8
1935	10th-15th	20-39	F	Pha prox hand	146.6	43.3	16.2	3.1	-20.3	12.3
1938	10th-12th	20-59	H	MTT 5 R	51.5	43.2	16.0	3.2	-20.1	11.1
2001	10th-15th	20-39	F	Pha prox hand	166.9	44.2	16.6	3.1	-19.8	11.1
2046	10th-15th	>20	I	Pha prox hand	142.0	42.4	15.9	3.1	-20.4	11.3
2112	10th-15th	20-59	F	Pha prox hand	116.5	42.2	15.7	3.1	-20.0	11.7
2120	10th-15th	20-39	H	MTC 2 L	192.1	42.2	15.9	3.1	-19.8	11.6

Acknowledgments: The authors thank Steve Brookes and Ian Begley from IsoAnalytical Ltd. for the spectrometric analyses. We would also like to thank Alain Gueiffier, Cecile Enguehard-Gueiffier, Leslie Boudesocque-Delaye, Pierre-Olivier Delaye and all other members of EA 7502 SIMBA, for their warm welcome to their laboratory during the preparation of the collagen samples, and Philippe Rosset, Yves Tillet and François Lecompte of the CIRE platform of the Inra Centre-Val-de-Loire/CHRU of Tours for the scanner acquisitions, Elisabeth Lorans for her precious advice on this work and Inga Topolnicki for her attentive corrections. Finally, we also want to thank the anonymous reviewers for their careful reading of this paper and their valuable comments and suggestions which have helped to improve its quality.

Declarations of interest: The authors report no declarations of interest.

Funding source: This work was funded by UMR CITERES 7324 – LAT.

Captions (color should be used in print for figures 1, 2, 3, 4 and 6)

Figure 1: Location of Rigny and position of the grave of Individual 1437 in the excavated areas (credit: UMR CITERES 7324 – LAT).

Figure 2: View of the burial of Individual 1437 during excavations (credit: UMR CITERES 7324 – LAT).

Figure 3: Osteological features of the skull of Individual 1437 (A) Right anterolateral view; B) Atresia of the left acoustic meatus; C) Mandible in right lateral view; credit: Valentin Miclon).

Figure 4: 3D reconstruction of the skull of Individual 1437, cross section at the right ear; Red: osseous labyrinth cast; Arrow: acoustic meatus (credit: Samuel Bédécarrats).

Figure 5: Variability of the diameter of the acoustic meatus in medieval populations from Touraine, France (n=69) (credit: Samuel Bédécarrats).

Figure 6: Isotope ratios (δ^{15}N and δ^{13}C) of individuals from Notre-Dame of Rigny parish cemetery (credit: Valentin Miclon).

Table 1: Main skeletal characteristics of Individual 1437 in relation to those of the main disorders with mandibulofacial dysostosis, according to the criteria by Kabak et al., 2019; Katsanis and Jabs, 2020; Lines et al., 2020; Vincent et al., 2016. Skeletal features: - not consistent with; + occasionally observed; ++ highly consistent with.

Supplemental Table 1: Measurements of ear diameters and osteological and contextual data of 69 individuals from Touraine.

Supplemental Table 2: Osteological, chronological and biogeochemical data of 48 individuals from Rigny.

Bibliography

Agrimi, J., Crisciani, C., 1995. Charité et assistance dans la civilisation chrétienne médiévale, in: Grmek, M. (Ed.), Histoire de La Pensée Médicale En Occident. Editions du Seuil, Paris, pp. 151–174.

Alexander, M.M., Gerrard, C.M., Gutiérrez, A., Millard, A.R., 2015. Diet, society, and economy in late medieval Spain: Stable isotope evidence from Muslims and Christians from Gandía, Valencia. American Journal of Physical Anthropology 156, 263–273. https://doi.org/10.1002/ajpa.22647

Ambrose, S.H., 1990. Preparation and characterization of bone and tooth collagen for isotopic analysis. Journal of Archaeological Science 17, 431–451. https://doi.org/10.1016/0305-4403(90)90007-R

Audoin-Rouzeau, F., Sabban, F. (Eds.), 2007. Un aliment sain dans un corps sain: perspectives historiques. Deuxième colloque de l'Institut Européen d'Histoire et des Cultures de l'Alimentation. Presses Universitaires François-Rabelais, Tours.

Bocherens, H., Fizet, M., Mariotti, A., Lange-Badre, B., Vandermeersch, B., Borel, J.P., Bellon, G., 1991. Isotopic biogeochemistry (^{13}C, ^{15}N) of fossil vertebrate collagen: application to the study of a past food web including Neandertal man. Journal of Human Evolution 20, 481–492. https://doi.org/10.1016/0047-2484(91)90021-M

Boddington, A., Cadman, G., Cramp, R., Parsons, D., Pearson, T., Powell, F., 1996. Raunds Furnells: The Anglo-Saxon Church and Churchyard, Archaeological Report. English Heritage, Swindon.

Bruce, S.G., 2005. Monastic Sign Language in the Cluniac Customaries, in: Cochelin, I., Boynton, S. (Eds.), From Dead of Night to End of Day: The Medieval Customs of Cluny. Brepols Publishers, Turnhout, pp. 273–286. https://doi.org/10.1484/M.DM-EB.3.483

Burrell, C.L., Emery, M.M., Gonzalez, S., 2019. Paget's disease of bone in two medieval skeletons from Poulton Chapel, Cheshire, UK. International Journal of Osteoarchaeology 29, 922–933. https://doi.org/10.1002/oa.2807

Chang, C.C., Steinbacher, D.M., 2012. Treacher Collins Syndrome. Seminars in Plastic Surgery 26, 083–090. https://doi.org/10.1055/s-0032-1320066

Colleter, R., Clavel, B., Pietrzak, A., Duchesne, S., Schmitt, L., Richards, M.P., Telmon, N., Crubézy, É., Jaouen, K., 2019. Social status in late medieval and early modern Brittany: insights from stable isotope analysis. Archaeological and Anthropological Sciences 11, 823–837. https://doi.org/10.1007/s12520-017-0547-9

DeNiro, M.J., 1985. Postmortem preservation and alteration of in vivo bone collagen isotope ratios in relation to palaeodietary reconstruction. Nature 317, 806–809. https://doi.org/10.1038/317806a0

Dufaÿ, B., Capron, F., Gaultier, M., 2018. La Riche, Prieuré Saint-Cosme. Rapport de fouilles archéologiques - Tome 1. Conseil départemental d'Indre-et-Loire, SRA Centre, Tours, Orléans.

Dutailly, B., Coqueugniot, H., Desbarats, P., Gueorguieva, S., Synave, R., 2009. 3D surface reconstruction using HMH algorithm. IEEE, pp. 2505–2508. https://doi.org/10.1109/ICIP.2009.5413911

Fazen, L.E., Elmore, J., Nadler, H.L., 1967. Mandibulo-Facial Dysostosis: (Treacher-Collins Syndrome). American Journal of Diseases of Children 113, 405–410. https://doi.org/10.1001/archpedi.1967.02090190051001

Flandrin, J.-L., Montanari, M. (Eds.), 1996. Histoire de l'alimentation. Fayard, Paris.

Gorlin, R.J., Cohen, M.M., Hennekam, R.C.M., 2001. Syndromes of the head and neck, 4th ed. ed, Oxford monographs on medical genetics. Oxford University Press, Oxford ; New York.

Guyomarc'h, P., Santos, F., Dutailly, B., Desbarats, P., Bou, C., Coqueugniot, H., 2012. Three-dimensional computer-assisted craniometrics: A comparison of the uncertainty in measurement induced by surface reconstruction performed by two computer programs. Forensic Science International 219, 221–227. https://doi.org/10.1016/j.forsciint.2012.01.008

Herrscher, E., 2003. Alimentation d'une population historique. Analyse des données isotopiques de la nécropole Saint-Laurent de Grenoble (XIII^{e}-XV^{e} siècle, France). Bulletins et Mémoires de la Société d'Anthropologie de Paris 149–269.

Hoffman, S., Sadler, L., Totman, T., Bagne, L., 2019. A Possible case of Facio-Auriculo-Vertebral sequence (FAVs) in an adult female from medieval Iceland (13th–16th Century). International Journal of Paleopathology 24, 41–47. https://doi.org/10.1016/j.ijpp.2018.08.009

Hsy, J., 2016. Symptom and Surface: Disruptive Deafness and Medieval Medical Authority. Bioethical Inquiry 13, 477–483. https://doi.org/10.1007/s11673-016-9744-y

Kabak, S.L., Savrasova, N.A., Zatochnaya, V.V., Melnichenko, Y.M., 2019. Hemifacial microsomia: skeletal abnormalities evaluation using CBCT (case report). J Radiol Case Rep 13, 1–9. https://doi.org/10.3941/jrcr.v13i11.3687

Katsanis, S.H., Jabs, E.W., 2020. Treacher Collins Syndrome, in: Adam, M.P., Ardinger, H.H., Pagon, R.A., Wallace, S.E., Bean, L.J., Mirzaa, G., Amemiya, A. (Eds.), GeneReviews®. University of Washington, Seattle, Seattle.

Kjellström, A., Storå, J., Possnert, G., Linderholm, A., 2009. Dietary patterns and social structures in medieval Sigtuna, Sweden, as reflected in stable isotope values in human skeletal remains. Journal of Archaeological Science 36, 2689–2699. https://doi.org/10.1016/j.jas.2009.08.007

Lalauze-Pol, R., 2020. La prise en charge des grands syndromes cranio-maxillo-faciaux en ostéopathie pédiatrique (Thèse de doctorat). École pratique des hautes études - Université Paris sciences et lettres.

Laurioux, B., 2002. Manger au Moyen Age: pratiques et discours alimentaires en Europe aux XIV^{e} et XV^{e} siècles. Hachette littératures, Paris.

Laurioux, B., 2011. Écrits et images de la gastronomie médiévale, Conférences Léopold Delisle. Bibliothèque nationale de France, Paris.

Lines, M., Hartley, T., MacDonald, S.K., Boycott, K.M., 2020. Mandibulofacial Dysostosis with Microcephaly, in: Adam, M.P., Ardinger, H.H., Pagon, R.A., Wallace, S.E., Bean, L.J., Mirzaa, G., Amemiya, A. (Eds.), GeneReviews®. University of Washington, Seattle, Seattle (WA).

Longin, R., 1971. New Method of Collagen Extraction for Radiocarbon Dating. Nature 230, 241–242. https://doi.org/10.1038/230241a0

Lorans, É. (Ed.), 2006. Saint-Mexme de Chinon, V^{e}-XX^{e} siècles. Ed. du CTHS, Paris, France.

Marres, H.A.M., Cremers, W.R.J., Dixon, M.J., Huygen, P.L.M., Joosten, F.B.M., 1995. The Treacher Collins Syndrome: A Clinical, Radiological, and Genetic Linkage Study on Two Pedigrees. Archives of Otolaryngology–Head & Neck Surgery 121, 509–514. https://doi.org/10.1001/archotol.1995.01890050009002

Metzler, I., 2006. Disability in medieval Europe: thinking about physical impairment during the High Middle Ages, c. 1100 - 1400, Routledge studies in medieval religion and culture. Routledge, London.

Müldner, G., Richards, M.P., 2005. Fast or feast: reconstructing diet in later medieval England by stable isotope analysis. Journal of Archaeological Science 32, 39–48. https://doi.org/10.1016/j.jas.2004.05.007

Müldner, G., Richards, M.P., 2007a. Stable isotope evidence for 1500 years of human diet at the city of York, UK. American Journal of Physical Anthropology 133, 682–697. https://doi.org/10.1002/ajpa.20561

Müldner, G., Richards, M.P., 2007b. Diet and diversity at later medieval fishergate: The isotopic evidence. American Journal of Physical Anthropology 134, 162–174. https://doi.org/10.1002/ajpa.20647

Murail, P., Bruzek, J., Houët, F., Cunha, E., 2005. DSP: A tool for probabilistic sex diagnosis using worldwide variability in hip-bone measurements. Bulletins et mémoires de la Société d'Anthropologie de Paris 17 (3–4), 167–176.

Pentassuglia, P., 2011. La reconnaissance de la diversité au XVI^{e} siècle. À propos de la difformité. Alter 5, 233–248. https://doi.org/10.1016/j.alter.2011.09.001

Phelps, P.D., Poswillo, D., Lloyd, G. a. S., 1981. The ear deformities in mandibulofacial dysostosis (Treacher Collins syndrome). Clinical Otolaryngology & Allied Sciences 6, 15–28. https://doi.org/10.1111/j.1365-2273.1981.tb01782.x

Polet, C., Katzenberg, M.A., 2002. Comportements alimentaires de trois populations médiévales belges: apports de la biogéochimie isotopique. Revue belge de philologie et d'histoire 80, 1371–1390. https://doi.org/10.3406/rbph.2002.4673

Posnick, J.C., Ruiz, R.L., 2000. Treacher Collins Syndrome: Current Evaluation, Treatment, and Future Directions. The Cleft Palate-Craniofacial Journal 37, 1–22. https://doi.org/10.1597/1545-1569_2000_037_0434_tcscet_2.0.co_2

Ravoire, F., Dietrich, A. (Eds.), 2009. La cuisine et la table dans la France de la fin du Moyen Âge: contenus et contenants du XIV^{e} au XVI^{e} siècle. Publications du CRAHM, Caen.

Reitsema, L.J., Kozłowski, T., Crews, D.E., Katzenberg, M.A., Chudziak, W., 2017. Resilience and local dietary adaptation in rural Poland, 1000–1400 CE. Journal of Anthropological Archaeology 45, 38–52. https://doi.org/10.1016/j.jaa.2016.11.001

Richards, M.P., Mays, S., Fuller, B.T., 2002. Stable carbon and nitrogen isotope values of bone and teeth reflect weaning age at the Medieval Wharram Percy site, Yorkshire, UK. American Journal of Physical Anthropology 119, 205–210. https://doi.org/10.1002/ajpa.10124

Salvat, M., 1984. Du bon usage de la chair, de l'eau et du vin d'après le De proprietatibus rerum de Barthélemi l'Anglais (XIII^{e} s.), in: Menjot, D. (Ed.), Manger et boire au Moyen Age: actes du colloque de Nice (15-17 octobre 1982). Tome 2 : Cuisine, manières de table, régimes alimentaires. les Belles lettres, Paris, pp. 331–342.

Sando, I., Takahara, T., Ogawa, A., 1984. Congenital Anomalies of the Inner Ear. Annals of Otology, Rhinology & Laryngology 93, 110–118. https://doi.org/10.1177/00034894840930S419

Schmitt, A., 2005. Une nouvelle méthode pour estimer l'âge au décès des adultes à partir de la surface sacro-pelvienne iliaque. Bulletins et mémoires de la Société d'Anthropologie de Paris 17 (1–2), 89–101.

Spoor, C.F., Zonneveld, F.W., Macho, G.A., 1993. Linear measurements of cortical bone and dental enamel by computed tomography: Applications and problems. American Journal of Physical Anthropology 91, 469–484. https://doi.org/10.1002/ajpa.1330910405

Stirland, A.J., 1997. Care in the Medieval community. International Journal of Osteoarchaeology 7, 587–590. https://doi.org/10.1002/(SICI)1099-1212(199711/12)7:6<587::AID-OA340>3.0.CO;2-J

The Treacher Collins Syndrome Collaborative Group, Dixon, J., Edwards, S.J., Gladwin, A.J., Dixon, M.J., Loftus, S.K., Bonner, C.A., Koprivnikar, K., Wasmuth, J.J., 1996. Positional cloning of a gene involved in the pathogenesis of Treacher Collins syndrome. Nature Genetics 12, 130–136. https://doi.org/10.1038/ng0296-130

Theureau, C., 1985. Anthropologie des squelettes du cimetière paroissial de Saint-Pierre-le-Puellier (XI^{e}-XVII^{e} siècle), Supplément à la revue archéologique du centre de la France. Laboratoire d'archéologie urbaine, Tours.

Theureau, C., 2007. Étude anthropologique d'un cimetière de paroisse rurale : les sépultures (8^{e}-19^{e} s.) de Rigny (Rigny-Ussé, Indre-et-Loire). Revue archéologique du Centre de la France 33.

Tilley, L., 2015. Theory and Practice in the Bioarchaeology of Care. Springer International Publishing, Cham. https://doi.org/10.1007/978-3-319-18860-7

Trainor, P.A., Dixon, J., Dixon, M.J., 2009. Treacher Collins syndrome: etiology, pathogenesis and prevention. Eur J Hum Genet 17, 275–283. https://doi.org/10.1038/ejhg.2008.221

van Klinken, G.J., 1999. Bone Collagen Quality Indicators for Palaeodietary and Radiocarbon Measurements. Journal of Archaeological Science 26, 687–695. https://doi.org/10.1006/jasc.1998.0385

Velle, K., 1998. Pour une histoire sociale et culturelle de la médecine. SARTONIANA 11, 157–191.

Verano, J.W., 2016. Differential diagnosis: Trepanation. International Journal of Paleopathology 14, 1–9. https://doi.org/10.1016/j.ijpp.2016.04.001

Vincent, M., Geneviève, D., Ostertag, A., Marlin, S., Lacombe, D., Martin-Coignard, D., Coubes, C., David, A., Lyonnet, S., Vilain, C., Dieux-Coeslier, A., Manouvrier, S., Isidor, B., Jacquemont, M.-L., Julia, S., Layet, V., Naudion, S., Odent, S., Pasquier, L., Pelras, S., Philip, N., Pierquin, G., Prieur, F., Aboussair, N., Attie-Bitach, T., Baujat, G., Blanchet, P., Blanchet, C., Dollfus, H., Doray, B., Schaefer, E., Edery, P., Giuliano, F., Goldenberg, A., Goizet, C., Guichet, A., Herlin, C., Lambert, L., Leheup, B., Martinovic, J., Mercier, S., Mignot, C., Moutard, M.-L., Perez, M.-J., Pinson, L., Puechberty, J., Willems, M., Randrianaivo, H., Szaskon, K., Toutain, A., Verloes, A., Vigneron, J., Sanchez, E., Sarda, P., Laplanche, J.-L.,

Collet, C., 2016. Treacher Collins syndrome: a clinical and molecular study based on a large series of patients. Genetics in Medicine 18, 49–56. https://doi.org/10.1038/gim.2015.29

Yoder, C., 2010. Diet in medieval Denmark: a regional and temporal comparison. Journal of Archaeological Science 37, 2224–2236. https://doi.org/10.1016/j.jas.2010.03.020

Yoder, C., 2012. Let them eat cake? Status-based differences in diet in medieval Denmark. Journal of Archaeological Science 39, 1183–1193. https://doi.org/10.1016/j.jas.2011.12.029

Zadora-Rio, E., Galinié, H., Husi, P., Motteau, J., Rodier, X., Sénégas, M.-L., Theureau, C., 2020. L'église de Rigny et ses abords. De la *colonia* de Saint-Martin de Tours au transfert du centre paroissial (600-1865). URL https://www.unicaen.fr/puc/rigny/accueil