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## Dental twinning in the primary dentition: new archaeological cases from Italy \*

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## Abstract

Dental twinning (or “double teeth”) is a rare developmental condition that implies the fusion of two or more adjacent teeth. Clinical literature reports individual cases and extensive population studies to clarify causation, distribution, heritability and differential diagnosis of the different types of dental twinning (i.e. fusion, gemination, and accretion) whereas, documentation for past populations is still scarce. Aims: the present study documents four new archaeological cases of dental twinning of deciduous teeth from four different Italian archaeological sites and positions them within the framework of the known literature. Materials and methods: the observed cases include five deciduous teeth from four subadults from Sardinia (Monte Sirai, 7th-4th cent. BCE and Santa Filitica, 7th cent. CE), Campania (Velia, 1st-2nd cent. CE) and Latium (Villamagna, 13th-15th cent. CE). The identification, descriptions and differential diagnoses of the anomalies were performed with the use of morphological analyses and, in one case, radiographic means. Results: all cases fall within the category of double teeth; each involving a different set of processes (gemination and dental fusion), teeth (deciduous central incisors, lateral incisors and canines), locations (upper and lower) and occurrence (unilateral and bilateral). Conclusion: to this day, cases reported in literature of dental twinning in archaeological samples are sparse and limited to specific geographical areas. This study adds four more cases from Italy suggesting such anomalies should be recorded in dental analyses in order to, one day, obtain a more reliable modelling of the frequencies and distributions in past populations.

**Keywords:** dental anomalies; double teeth; primary dentition; bioarchaeology; Italy

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## Introduction

Primary and permanent dentitions may present anomalies in the morphology, number, and position of the teeth (1–4). Among these is dental twinning (also known as the occurrence of ‘double teeth’ or ‘connate teeth’), which is a rare developmental disorder that manifests through either the fusion of two or more adjacent teeth or the partial development of two incomplete, fused teeth, in place of a single one. The etiology of dental twinning is yet to be fully understood and has been associated to a number of causative factors among which disorders in odontogenesis, specific diseases, infections, medical therapies, environmental disturbances (3,5–11), and genetics (12–14).

Clinical literature indicates dental twinning may occur in three different manners, each with its specific underlying etiology: gemination (the partial development of two teeth from a single dental germ), fusion (union of two teeth from different germs); and concrescence (union of two roots brought about by hyperplastic cementum) (2,3,7,10,15,16).

Gemination, or shizodonthis, is the formation of two crowns from a single bud (17,18). During odontogenesis, the tooth germ divides by invagination generating a tooth that has two partially or entirely separated equivalent crowns

above a shared root and root canal (19). The anomalous tooth can result in mirror images of the coronal halves (20,21), it is counted as a single entity, it is characterized by a mesio-distal diameter that is above the norm (22), and it is most common in the anterior maxillary dentition (21,23). It does not cause, in itself, a disruption in the normal number of teeth present (24).

Fusion, or synodontia, is the union of the dentin and/or of the enamel of two or more separately developing teeth (4); supposedly in consequence of proximity between tooth germs and physical pressure during growth. The fusion, resulting in an abnormally large tooth in which the crowns often unite at an angle (20,21), can be complete or incomplete, depending on the developmental stage at which it occurs. As a consequence, the pulp chamber and root canal can be independent or, to some degree, joined and the affected quadrant will be missing a tooth (24). Dental fusion is principally observed in the deciduous anterior dentition (25) where it can occur between normal teeth or involve one or more supernumerary ones (21,23,26–28). ‘Triple teeth’ are particularly rare and can be characterized by different types of associations; in the majority of cases, the condition derives from the fusion of at least a supernumerary or geminate tooth

whereas, only in truly sporadic cases, all three of the teeth involved are standard (29–33).

Concrescence is the union of two adjacent teeth by an excess layer of cementum. The underlying dentine, the root canals and the pulp chambers remain independent, and for the most part unaffected, whereas the cementum goes uninterruptedly from one tooth to the other joining them (34–36). This anomaly is chiefly observed in the posterior maxillary region uniting, in particular, the second and third molar. It may develop during root formation (developmental or true concrescence) or later (post-inflammatory or acquired concrescence). The main causative factors involved in the case of true concrescence, appear to be root proximity and overcrowding whereas traumatic injuries, local infections, chronic inflammatory responses and excessive occlusal forces could contribute, or be responsible for, acquired concrescence (36).

Double teeth may correlate with other dental anomalies such as anodontia, ectopic or delayed eruption, peg-shaped incisors, or talon cusps (35,37–44). They may also be the direct cause of dental over-spacing or crowding, dental malalignment, malocclusion or arch asymmetry. In a number of instances individuals with primary double teeth have been shown to be also affected by twinning of the underlying permanent teeth (39,45). Furthermore, the presence, at times, of a deep groove between the split or fused crowns seems to render the teeth more susceptible to caries (19,28,33,37,46).

According to contemporary epidemiological studies, the prevalence of double teeth (fusion and gemination) varies between 0.1 and 5%, with higher frequencies in Asian and Asian-derived populations (8,14,41,47–50). The large discrepancies observed among studies and populations has, in most cases, been attributed to genetic variability. However, one should not underestimate the influence that biases or screening methodologies could have had on such statistics. One need only reflect on the fact that most of the studies report data on patients attending clinical services, possibly overestimating the rates for the general population, or that there do not appear to be systematic studies throughout the world but that these, quite the contrary, tend to be concentrated in specific regions.

In general studies indicate primary dentitions, and in particular anterior mandibular teeth, are the most frequently affected (7,37,40,47) and that incidence in permanent teeth is extremely low and, as such, seldom reported in literature (51–

55). Furthermore, they indicate that bilateral occurrence is infrequent (12,22,37) and that it appears to be independent of sex as most studies report a similar incidence in males and females (14,40,56–58).

### Materials and methods

The present study reports four new archaeological cases from Italy (Figure 1): one from the Phoenicio-Punic necropolis at Monte Sirai (Sardinia, 7th-4th cent. BCE), one from the Roman Imperial necropolis of Velia (Campania, 1st-3rd cent. CE), one from the site of Santa Filittica (Sardinia, 7th cent. CE), and one from the late medieval cemetery of Villamagna (Latium, 13th-15th cent. CE).



Figure 1. Geographic locations of the four archaeological cases reported in this study.

### Monte Sirai

The necropolis of Monte Sirai (Sardinia) is located in southwestern Sardinia, approximately 10 km from the coast, at the foot of the hill where the homonymous settlement was uncovered. It includes burials from the Phoenician and Punic periods as well as some sporadic depositions dated to the Hellenistic period just before the settlement was abandoned. The oldest burials date to the end of the 7th century BCE, while the

most recent ones are dated to the second half of the 4th century BCE (59).

The excavation campaigns led in 2003 and 2004 brought to the unearthing of 54 tombs with different types of depositions among which: 13 incinerations, 11 pit inhumations, 16 depositions in amphora (enkytrismos), and 12 for which deposition data has not been provided. 41 of these burials are currently under study and stored at the Bioarchaeology Service of the Museum of Civilizations in Rome. The subadult discussed in the present study was uncovered in Tomb 211 and is identified as T.211/2.

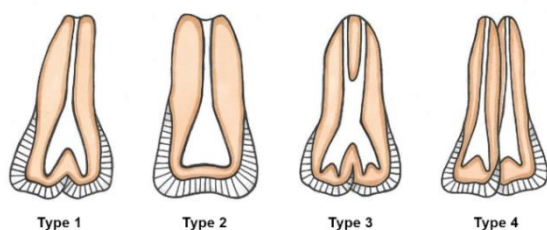


Figure 2. Types of double teeth according to Aguiló and colleagues (80). Redrawn from (80,33) (by Sara Cimaglia).



Figure 3. Monte Sirai, upper right deciduous double tooth of individual 211/2 (lingual view).

#### Velia

The necropolis of Velia Porta Marina (Campania, 1st-2nd cent. CE) was excavated between 2003 and 2006 (60), and yielded hundreds of burials with different characteristics, from monumental tombs to simple earthen burials. Most of the individuals were inhumated, but cremations and busta (in situ cremations) were present as well

(61). The skeletal remains (pertaining to over 350 individuals) are under study by the Bioarchaeology Service of the Museum of Civilizations. The anthropological analyses aim at reconstructing the funerary rituals and describing the demographic and bio-social characteristics of the ancient inhabitants of Velia. So far, evidence regarding the sex and age composition of the sample (62), health status (63–65), prevalent working activities (66,67), diet (68), migration phenomena and individual mobility (69) have been collected. The subadult object of the present study is identified as T. 133.

#### Santa Filitica

The site of Santa Filitica, Sorso (Sardinia) is located on the northwestern coast of Sardinia. It comprises of Roman baths and two settlements, one dated to the 6th cent. CE and the other to the 7th (70). Excavations conducted throughout the years have brought to the discovery of burials dated to both the Vandalic (4 depositions, all adult) and the Byzantine (16 adults, 5 children) phases within those that used to be the roman baths and the cistern as well as beneath some houses dated to the 7th cent. CE (71,72). Among these were some tombs, lined with vertically placed lithic slabs, uncovered in the northeastern portion of the Byzantine village (71). One of which, Tomb 5000, was a collective tomb dated to the 7th cent. CE that contained the remains of three adult individuals and the infant object of the present study identified as Ind. 5000/3.

#### Villamagna

The medieval necropolis of Villamagna, Anagni (Latium), was excavated from 2006 to 2010 and saw the unearthing of 421 articulated primary burials dated from the 8th to the 15th cent. CE (73). The osteological remains collected were restored, catalogued and analyzed obtaining a general outline of the demographic profile, the variability and the living conditions of the rural, peasant, population that had been buried at Villamagna (74). The information uncovered during this preliminary survey of the remains brought to the development of numerous research questions and queries some of which have since become focus of dedicated studies (75–77). The subadult under study, identified as HRU\_2341, has been attributed on the basis of archaeological data and the radiocarbon dates obtained at Villamagna, to the late medieval phase of the necropolis and dated to between 1280 and 1430 cal. CE (73).

Age at death was estimated on the basis of dental development (78) and diaphyseal length (79). The dental defects detected were assessed morphologically, described and, when possible, classified according to Aguiló and colleagues' (80) categorical system in which double teeth are divided into four types on the basis of root and crown morphology (Figure 2). According to such system the crowns can be bifid (BC), large (LC), or fused (FC), the root can be single (SR), large (LR), double conical (DCR) or two fused roots (FR), and the combination of such characteristics brings to the definition of four main types: Type-1 (BC + SR), Type-2 (LC + LR), Type-3 (FC + DCR), and Type-4 (FC + FR).



**Figure 2.** Mandible of Velia 133 with bilateral dental fusion between the lateral incisors and the canines (anterior view).



**Figure 3.** Primary mandibular front teeth of Velia 133 showing the partial fusion of crowns and roots of the lateral incisors and canines (lingual view).

X-ray images of the individual from Velia were obtained through the medical equipment GENDEX DENTPLY (ORALIX AC TYPE 98690000101 KV65), exposing the mandible

and loose teeth at 7.5 mA for 0.7 sec. The resulting images were analyzed using VistaNet/VistaScan Perio Plus 21, and DBSWIN 5.1.1; resolution was 1283 (25.26) dpi.

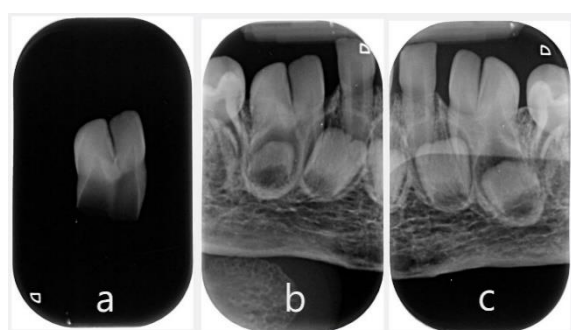
## Results

Monte Sirai, individual 211/2 - double tooth  
Tomb 211 from Monte Sirai contained the remains of two individuals: a cremated adult and an unburnt 3-year-old individual, object of this study, identified as individual 2. Individual 2 is represented by a few incomplete postcranial bones, some cranial fragments, 12 observable deciduous teeth, and 5 permanent tooth buds (see Table 1). The double tooth present (Figure 3) has two crowns that are well separated in their apical portion but fused in their basal one, right above the neck. The two crowns differ in shape and size and diverge from what appears to be a single, shared, root canal; however, this last observation must be taken with due caution given that the root is preserved exclusively in its first millimeters.

Classification and a conclusive diagnosis is rendered particularly difficult due to crown morphology, the partiality of the remains, and post depositional damage: the partiality of the root, makes it impossible to determine if the sample should be categorized within Aguiló's (80) classification system as Type-3 or Type-4 whereas crown morphology and the absence of the supporting bone do not allow the distinction between gemination of the upper right deciduous central incisor and its fusion to, either, the corresponding lateral incisor or a supplementary tooth.

Velia, individual 133 – bilateral dental fusion  
Tomb 133 from Velia yielded the remains of a 1.5-2-year-old individual. The skeleton is almost complete, with the maxillary and mandibular bone fully preserved, yielding nine primary teeth and six permanent teeth buds (see Table 1). The individual shows bilateral fusion between the deciduous lower lateral incisor and canine. On both sides, the space occupied by the teeth is reduced with the presence of a diastema between the central and lateral deciduous lower incisors and between the lower canines and first deciduous molars (Figure 4). Macroscopically, the teeth are joined by the lower portion of the crown and along the root and fall within the Type-4 described by Aguiló et al. (80), i.e. two fused crowns, two fused roots. (Figure 5). The x-ray images (Figure 6a) show separate pulp chambers and root canals, hence the diagnosis

of a bilateral case of dental fusion from two different germs. Since this condition frequently affects the formation of the corresponding permanent teeth, leading to congenital absence of delayed formation (81–83), we obtained an x-ray for the mandible. The image shows the bilateral agenesis of the permanent lateral incisors (Figure. 6b,c). Other features of the dentition include slight dental winging of the lower central incisors.



**Figure 4.** X-rays of Velia 133: a. right incisor and canine; b and c, respectively, right and left mandibular arches showing the deciduous teeth, their permanent successors, and the agenesis of the permanent lateral incisors.



**Figure 5.** Santa Filitica, individual 5000/3. Upper right deciduous incisor with double crown (lingual view).

Santa Filitica, individual 5000/3 - double tooth  
Tomb 5000 US 5313 is a multiple deposition of three adults (2 females and one male) and a 9-month-old infant (Ind. 5000/3), that is only partially represented (there are a few skull fragments, some long bone portions and some elements of the rib cage). The infant has 13 primary teeth and 3 first permanent molars, all in formation (see Table 1). The upper right central

incisor shows two crowns of different morphologies that are joint just above the neck (Figure 7) and quite well defined one from the other, suggesting it falls within either the Type-3 or the Type-4 described by Aguiló et al. (80). The severe post depositional damage to the roots limits observations however, the careful observation of the maxilla shows the presence of a single, 8-shaped alveolus (possibly the confluence of two roots), suggesting that the defect is the result of the fusion between the upper right central and lateral incisors. The opposite tooth, the upper left central incisor, shows a regular morphology.

#### Villamagna, individual 2341 - double tooth

Excavated in 2007, individual 2341 is the almost complete skeleton of an approximately 2-3-year-old subadult with an almost complete mixed dentition: most of the deciduous teeth are present (the only ones missing are the upper left central incisor and the lower left central and lateral ones) as are the lower permanent central incisors and the first molars that are in crypt (see Table 1).

The upper right deciduous central incisor is double and shows, along the sulcus separating the two conjoint crowns, in the tooth's lingual aspect, a severe carious lesion. Macroscopically, the case appears to be classifiable as Type-3 (80) with both crowns and roots joined. (Figure 8). The presence of the lateral incisor indicates that this should be considered a case of gemination or of fusion with a supplementary tooth.

Overall, the new cases reported (Table 1) include a case of bilateral dental fusion, a case of dental fusion, and two cases of uncertain nature with the involvement of both the upper dentition (3 individuals) and the lower one (1 individual).

#### Discussion

The term “double teeth” and synonyms are often used to describe different kinds of anomalies: dental concrescence, gemination and fusion (84). Different studies and case descriptions have addressed the issue of their differential diagnosis, that is not always conclusive (11). The identification of dental concrescence is less challenging. Due to the peculiar morphology, location (roots), and type of dental tissue involved (cementum), this condition strongly differentiates from the other anomalies. In contrast, with crown involvement, the differential diagnosis between gemination and fusion may pose some diagnostic difficulties even in clinical cases; hence the “double teeth a diagnostic dilemma”

(22,39,85,86). Furthermore, when more than two teeth are interested, cases of mixed conditions may occur (26,27). Consequently, different authors suggest the more generic term of “double tooth” be employed to define the entire array of expressions that includes geminations and fusions between both regular and supernumerary teeth (87).

However, the main diagnostic features are the presence/absence of discernible roots and root canal systems and the number of teeth in the



**Figure 6.** Upper right deciduous central incisor of individual HRU\_2341 from Villamagna, showing the union of both crowns and roots as well as an evident carious lesion (lingual view).

dental arch involved (12,24,80): a reduced number of teeth may indicate dental fusion, while the expected number suggests a case of gemination, provided that cases of hypodontia or hyperdontia do not complicate the observation (31,88).

The diagnosis of archaeological cases can be further hampered by a number of factors among which incompleteness of the dentition, post-depositional damage of crowns, roots or alveolar portions of supporting bones. Nonetheless, in the present study we have been able to determine that all four individuals undoubtedly show dental twinning and establish that at least two can be categorized as dental fusion (Velia and Santa Filitica). In the other cases, the abovementioned limiting factors impeded a conclusive diagnosis.

As discussed above, double teeth are sometimes associated with pathologies or other anomalies, affecting both primary and secondary dentitions. Many studies have pointed to an increase of the susceptibility of fused teeth to carious lesions (44,84). This is the case of the subadult from Villamagna that has a carious lesion along the groove between the two crowns. Few studies have statistically investigated the effect of primary dental fusion on the secondary dentition. Zengin et al. (33) found cases of permanent double teeth, supernumerary teeth, and aplasia, the latter in 27% of the observations. Aguiló et al. (80) noted that successor anodontia is frequently associated with Type-3 primary double teeth. The x-ray images of the child from Velia, ind. 133, led to the identification of such condition in the permanent lateral incisors.

Dental twinning is rarely reported in past populations. To this day, only two cases have been described for the permanent dentition, one from Italy (89) and one from Northern Africa (90). Cases of double or triple deciduous teeth are instead somewhat more common and appear to have been reported in 24 different sites, 43 different individuals and 47 instances (Table 2). These are mostly from the USA, but there are also cases from Peru (one site), Japan (one site) and Europe (from Italy, the UK, Greece and Portugal). The cases from Italian archaeological contexts reported in the literature appear to be only two: the first, a triple tooth, object of a dedicated case study (89) and the other a photographed tooth that is briefly mentioned as being a Hutchinson tooth in a general overview of the site (91).

In both ancient (Table 2) and modern populations (28,37,80), the teeth that appear to be the most affected are the anterior ones. This trend is further supported by the cases reported in the present paper, all of which involve the anterior dentition. However, while only 6 of the 32 cases reported in literature for which location is indicated involve maxillary teeth 3 of the 4 cases, or 3 of the 5 teeth, reported in the present study regard the upper dentition (bringing the known cases for Italy to 6, of which 5 involving the upper dentition). As also observed by Aguiló et al. (80), all cases involving the central incisors were on the maxilla (Monte Sirai, Santa Filitica, and Villamagna) whereas all cases of fusion between the lateral incisor and the canine were on the mandible (Velia) where, furthermore, bilaterality was more common (Velia). Lastly, interesting is the fact that in Velia the fusion of the deciduous lateral incisors and canines was followed by the



agenesia of the permanent lateral incisors; an association that corresponds to the one observed by both Gellin (92) and Hagman (58) that is

reported by More et al. (28) as having a 100% chance of occurring.

**Table 1. Dentition of the four individuals showing double teeth; X = tooth present in its alveolus, ST = supplementary tooth, NR = tooth not recovered. Between parentheses dental identification according to the FDI World Dental Federation notation ISO System 3950.**

		Right						Left					
		M1	dm2	dm1	dc	di2	di1	di1	di2	dc	dm1	dm2	M1
Monte Sirai	upper	(16) NR	(55) loose	(54) NR	(53) NR	(52) NR	(51) gemination or fusion with i2 (52) or ST	(61) loose	(62) loose	(63) loose	(64) NR	(65) loose	(26) NR
	lower	(46) loose	(85) X	(84) X	(83) X	(82) X	(81) NR	(71) NR	(72) NR	(73) NR	(74) X	(75) X	(36) loose
Velia	upper	(16) crypt	(55) crypt	(54) X	(53) X	(52) X	(51) X	(61) X	(62) X	(63) X	(64) X	(65) crypt	(26) crypt
	lower	(46) crypt	(85) crypt	(84) X	(83 + 82) fusion		(81) X	(71) X	(72 + 73) fusion		(74) X	(75) crypt	(36) crypt
Santa Filitica	upper	(16) crypt	(55) crypt	(54) crypt	(53) X	(51 + 52) fusion		(61) X	(62) NR	(63) NR	(64) crypt	(65) crypt	(26) NR
	lower	(46) crypt	(85) crypt	(84) NR	(83) NR	(82) NR	(81) NR	(71) X	(72) X	(73) crypt	(74) crypt	(75) crypt	(36) crypt
Villa Magna	upper	(16) crypt	(55) X	(54) X	(53) X	(52) X	(51) gemination or fusion with ST	(61) NR	(62) X	(63) X	(64) X	(65) X	(26) crypt
	lower	(46) crypt	(85) X	(84) X	(83) X	(82) X	(81) X	(71) NR	(72) NR	(73) X	(74) X	(75) X	(36) crypt

**Table 2.** List of deciduous double teeth from archaeological sites; Dental identification according to the FDI World Dental Federation notation ISO System 3950; ST = supplementary tooth.

Site	Country	Date	Age (Years)	Quadrant	Double teeth	Sources
Monte Sirai	Italy	700-400 BCE	~3.0	UR	51 (gemination or fusion with 52 or ST)	Present Study
Velia	Italy	0-200 CE	1.5-2.0	LL&LR	72-73 & 82-83	Present Study
Santa Filitica	Italy	700 BCE	~9 months	UR	51-52	Present Study
Villamagna	Italy	1300-1500 CE	2.0-3.0	UR	51 (gemination or fusion with ST)	Present Study
Basento	Italy	979-1037 CE	-	UR	51 (gemination or fusion with ST)	(91)
St Martino in Rivosecco, Parma, Italy	Italy	1350-1400 CE	~5.0	UR	51-52-ST	(93)
Rema Xydias	Greece	1400-1100 BCE	1.0-2.0	LR	81-82	(94)
Miroico	Portugal	100-400 CE	3.0-4.0	LL	71-72	(95)
Wharram Percy, Yorkshire, UK	UK	950–1350 CE	4.0–5.0	LL	71-72	(96)
Caister-on-Sea, Norfolk, UK	UK	Early medieval	5.0–6.0	LR	82-83	(97,98)
Jemez Valley, New Mexico, USA	USA	-	8.0–10.0	LR	82-83	Ortner Research Slide Collection, in (15)
Camp Robinson, Nebraska, USA	USA	-	1.5	LR	81-82	Ortner Research Slide Collection, in (15)
Law's Site, Pine Island, Alabama	USA	8000-1000 BCE	~9 months	UL	61-62-63	(99)
Cherry 4, Tennessee, USA	USA	2500–1000 BCE	5.0–6.0	LR	82-83	(100)
Cherry 8, Tennessee, USA	USA	2500–1000 BCE	3.5-4.5	LR	81-82	(100)
Kays Landing 6, Tennessee, USA	USA	2500–1000 BCE	4.5–6.0	LL	72-73	(100)
Oak View Landing 46, Tennessee, USA	USA	2500–1000 BCE	0.5–0.75	LR	82-83	(100)
Late Archaic, Ohio Valley	USA	1200-700 BCE	-	-	1 case (N=35)	(101)
Wildcat Canyon, Oregon	USA	100 BCE - 1 CE	~5.0	LL	81-82	(102)
Anderson Village, Late Prehistoric, Ohio Valley	USA	1000-1650 CE	-	-	2 (N=6)	(101)



Site	Country	Date	Age (Years)	Quadrant	Double teeth	Sources
Buffalo, Late Prehistoric, Ohio Valley	USA	1000-1650 CE	-	-	1 (N=49)	(101)
Pearson, Late Prehistoric, Ohio Valley	USA	1000-1650 CE	-	-	1 (N=22)	(101)
SunWatch, Late Prehistoric, Ohio Valley	USA	1000-1650 CE	-	-	5 (N=69)	(101)
Averbuch, Tennessee	USA	1200-1500 CE	-	all lower	7 (N=132)	(103,104)
Arroyo Hondo, New Mexico, USA	USA	1300-1400 CE	4.0-5.0	UR	51-52	(105) in (15)
Citico 176, Tennessee, USA	USA	1300-1550 CE	3.0-4.0	LL	72-73	(100)
				LR	82-83	
				UL	61-62	
				UR	52-53	
Toqua 37, Tennessee, USA	USA	1300-1550 CE	~1.0	LL	71-72	(100)
				LR	81-82	(100)
Toqua 101, Tennessee, USA	USA	1300-1550 CE	1.5-2.0	LL	72-73	(100)
Toqua 115, Tennessee, USA	USA	1300-1550 CE	2-2.25	L	71-81	(100)
Toqua 212, Tennessee, USA	USA	1300-1550 CE	1.0-1.5	LR	81-82	(100)
Pueblo Viejo	Peru	600-1200 CE	-	LL	71-72	(106)
Pueblo Viejo	Peru	600-1200 CE	-	LR	81-82	(106)
Hitotsubashi Metropolitan High School Site	Japan	1600-1700 CE	~4.0	LL	72-73	(107)
Hitotsubashi Metropolitan High School Site	Japan	1600-1700 CE	~4.0	LR	81-82	(107)
Hitotsubashi Metropolitan High School Site	Japan	1600-1700 CE	~2.0	LR	82-83	(107)
Hitotsubashi Metropolitan High School Site	Japan	1600-1700 CE	~3.0	LR	82-83	(107)

## Conclusion

Despite the extensive clinical literature on dental twinning, the number of archaeological cases so far reported, due both to the rarity of the phenomenon and to its transient nature, is extremely limited. In the present study, we provide a review of the available literature and describe four new cases of dental twinning from Italian archaeological sites. All cases are related

to the anterior primary teeth but involve different types of teeth. In only one case we were able to reach a conclusive diagnosis of “dental fusion” (Velia), while the other three cases were more generally recorded as “double teeth”, due to the lack of strong evidence for a differential diagnosis between fusion and gemination.



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## Author contributions

AS conceptualized the study; AS, FC and LF performed the study; AS and FC wrote the manuscript with input from all authors; MB, CC, FC, LC, EF, LF, EG, SI and AS provided the samples and the archaeological and anthropological framework.

## References

1. Brabant H. Comparison of the characteristics and anomalies of the deciduous and the permanent dentition. *J Dent Res.* 1967 Sep-Oct;46(5):897-902. doi: 10.1177/00220345670460054701. PMID: 5234030.
2. Nowak AJ, Christensen JR, Mabry TR, Townsend JA, Wells M. Pediatric dentistry: infancy through adolescence. 2019. 656 p.
3. Ortner DJ. Identification of pathological conditions in human skeletal remains. 2nd ed. San Diego, CA: Academic Press; 1981. 479 p.
4. Pindborg JJ. Pathology of the dental hard tissues. Copenhagen: Munksgaard; 1970. 445 p.
5. Puy L, Pizarro C, Navarro F. Double teeth: case reports. *J Clin Pediatr Dent.* 1991 Winter;15(2):120-4. PMID: 1931747.
6. Meadors LW, Jones HL. Fused primary incisors with succedaneous supernumerary in the area of a cleft lip: case report. *Pediatr Dent.* 1992 Nov-Dec;14(6):397-9. PMID: 1303550.
7. Neville BW, Damm DD, Allen CM, Chi AC. Oral and maxillofacial pathology. 4th ed. St. Louis, Missouri, USA: Elsevier; 2016. 878 p.
8. Nik-Hussein NN, Salcedo AH. Double teeth with hypodontia in identical twins. *ASDC J Dent Child.* 1987 May-Jun;54(3):179-81. PMID: 3473097.
9. Santos KSA, Lins CCSA, Almeida-Gomes F, Travassos RMC, Santos RA. Anatomical Aspects of Permanent Geminate Superior Central Incisives. *Int J Morphol.* 2009;27(2):515-7.
10. Scheid RC, Woelfel JB. Woelfel's dental anatomy: its relevance to dentistry. 7th ed. Philadelphia: Lippincott Williams & Wilkins; 2007. 534 p.
11. Shrestha A, Marla V, Shrestha S, Maharjan IK. Developmental anomalies affecting the morphology of teeth – a review. *RSBO.* 2016;12(1):68.
12. Duncan WK, Helpin ML. Bilateral fusion and gemination: a literature analysis and case report. *Oral Surg Oral Med Oral Pathol.* 1987 Jul;64(1):82-7. doi: 10.1016/0030-4220(87)90121-6. PMID: 3475662.
13. Gurri FD, Balam G. Inheritance of Bilateral Fusion of the Lower Central and Lateral Incisors: A Pedigree of a Maya Family from Yucatan, Mexico. *Dent Anthr J.* 2018;19(1):29-34.
14. Tasa GL, Lukacs JR. The prevalence and expression of primary double teeth in western India. *ASDC J Dent Child.* 2001 May-Jun;68(3):196-200. PMID: 11693013.
15. Lewis M. Paleopathology of children: identification of pathological conditions in the human skeletal remains of non-adults. London, United Kingdom: Elsevier/AP, Academic Press, an imprint of Elsevier; 2017. 288 p.
16. Schuur A. Pathology of the hard dental tissues. Chichester, West Sussex Oxford Ames, Iowa: Wiley-Blackwell, A John Wiley & Sons, Ltd., Publication; 2013. 446 p.
17. Miles AE. Malformations of the teeth. *Proc R Soc Med.* 1954 Oct;47(10):817-26. PMID: 13215512; PMCID: PMC1918972.
18. Tannenbaum KA, Alling EE. Anomalous tooth development. Case reports of gemination and twinning. *Oral Surg Oral Med Oral Pathol.* 1963 Jul;16:883-7. doi: 10.1016/0030-4220(63)90326-8. PMID: 13984880.
19. Rajeswari MRC, Ananthalakshmi R. Gemination-Case report and review. *Ind J Multi Dent.* 2011;1(6):355.
20. Khurana P, Khurana K. Esthetic and endodontic management of fused maxillary lateral incisor and supernumerary teeth with all ceramic restoration after trauma. *Saudi End J.* 2014;4(1):23.
21. Schuur AH, van Loveren C. Double teeth: review of the literature. *ASDC J Dent Child.* 2000 Sep-Oct;67(5):313-25. PMID: 11068663.
22. Knezević A, Travan S, Tarle Z, Sutalo J, Janković B, Ciglar I. Double tooth. *Coll Antropol.* 2002 Dec;26(2):667-72. PMID: 12528297.
23. Gupta S, Goel M, Dutta S. Synodontia between Permanent Maxillary Lateral Incisor and A Supernumerary Tooth: Surgical Treatment Perspective. *J Oral Health Comm Dent.* 2007;1(3):52-5.



24. Levitas TC. Geminatio, Fusio, Twinning and Concrecence. *J Dent Child (Chic)*. 1965;32:93-100. PMID: 14285597.
25. Shrivastava S, Tijare M, Singh S. Fusion/Double Teeth. Kailasam S, editor. *J Ind Acad Oral Med Rad*. 2011;23:5468-70.
26. Benazzi S, Buti L, Franzo L, Kullmer O, Winzen O, Gruppioni G. Report of three fused primary human teeth in an archaeological material. *Int J Osteoarch*. 2009;20:481-5.
27. Lagarde M, Bonnet AL, Douangmala N, Traing M, Dursun E. Simultaneous occurrence of triple teeth and double teeth in primary dentition: A rare case report and review of the literature. *Clin Case Rep*. 2020 Apr 29;8(7):1277-1286. doi: 10.1002/ccr3.2876. PMID: 32695375; PMCID: PMC7364066.
28. More CB, Tailor MN. Tooth fusion, a rare dental anomaly: Analysis of six cases. *J Oral Maxillofac Pathol* 2012;4(1):50-3.
29. Babaji P, Prasanth MA, Gowda AR, Ajith S, D'Souza H, Ashok KP. Triple teeth: report of an unusual case. *Case Rep Dent*. 2012;2012:735925. doi: 10.1155/2012/735925. Epub 2012 Dec 17. PMID: 23346424; PMCID: PMC3533612.
30. Mohapatra A, Prabhakar AR, Raju OS. An unusual triplication of primary teeth-a rare case report. *Quintessence Int*. 2010 Nov-Dec;41(10):815-20. PMID: 20927417.
31. Nagaveni NB, Yadav S, Sanalkumar D. Triple and Double Teeth in the Same Quadrant: Report of a Rare Case with Literature Review. *Journal of Dentistry and Orofacial Surgery*. 2016;01(04):117.
32. Prabhakar AR, Marwah N, Raju OS. Triple teeth: case report of an unusual fusion of three teeth. *J Dent Child (Chic)*. 2004 Sep-Dec;71(3):206-8. PMID: 15871454.
33. Zengin AZ, Celenk P, Gunduz K, Canger M. Primary double teeth and their effect on permanent successors. *Eur J Paediatr Dent*. 2014 Sep;15(3):309-12. PMID: 25306150.
34. Foran D, Komabayashi T, Lin LM. Concrecence of permanent maxillary second and third molars: case report of non-surgical root canal treatment. *J Oral Sci*. 2012 Mar;54(1):133-6. doi: 10.2334/josnusd.54.133. PMID: 22466898.
35. Gündüz K, Açıkgöz A. An unusual case of talon cusp on a geminated tooth. *Braz Dent J*. 2006;17(4):343-6. doi: 10.1590/s0103-64402006000400014. PMID: 17262150.
36. Meer Z, Rakesh N. Concrecence in Primary Dentition: A Case Report. *International Journal of Clinical Dental Science*. 2011;2(2):19-21.
37. Açıkel H, İbiş S, Şen Tunç E. Primary Fused Teeth and Findings in Permanent Dentition. *Med Princ Pract*. 2018;27(2):129-132. doi: 10.1159/000487322. Epub 2018 Feb 1. PMID: 29402820; PMCID: PMC5968246.
38. Costa AC, Nascimento BS do, Silva JLC, Santos AMC, Cruz SC da C, Fernandes ML da MF. Fused teeth in the primary dentition: clinical case report. *Revista Gaúcha de Odontologia*. 2020;68:e20200051.
39. Killian CM, Croll TP. Primary and permanent incisor twinning defects in one dental quadrant: report of a case. *Quintessence Int*. 1990 May;21(5):363-5. PMID: 2243939.
40. Mukhopadhyay S, Mitra S. Anomalies in primary dentition: Their distribution and correlation with permanent dentition. *J Nat Sci Biol Med*. 2014 Jan;5(1):139-43. doi: 10.4103/0976-9668.127313. PMID: 24678213; PMCID: PMC3961919.
41. Niswander JD, Sujaku C. Congenital anomalies of teeth in Japanese children. *Am J Phys Anthropol*. 1963 Dec;21(4):569-74. doi: 10.1002/ajpa.1330210413. PMID: 14185534.
42. Nuvvula S, Pavuluri C, Mohapatra A, Nirmala SV. Atypical presentation of bilateral supplemental maxillary central incisors with unusual talon cusp. *J Indian Soc Pedod Prev Dent*. 2011 Apr-Jun;29(2):149-54. doi: 10.4103/0970-4388.84689. PMID: 21911955.
43. Rao AVP, Reddy NV, Krishnakumar R, Sugumaran DK, Mohan G, A.R. Senthil Eagappan. Primary double tooth with partial anodontia of permanent dentition - a case report. *Journal of Clinical and Experimental Dentistry*. 2010;e79-81.
44. Yuen SW, Chan JC, Wei SH. Double primary teeth and their relationship with the permanent successors: a radiographic study of 376 cases. *Pediatr Dent*. 1987 Mar;9(1):42-8. PMID: 3472185.
45. Agali RJ, Nihal NK, Vora MS. Dental twinning in Primary Dentition: A Case report. *Journal of South Asian Association of Pediatric Dentistry*. 2018;1(1):27-9.
46. Hunasgi S, Koneru A, Manvikar V, Vanishree M, Amrutha R. A Rare Case of Twinning Involving Primary Maxillary Lateral Incisor with Review of Literature. *J Clin Diagn Res*. 2017 Feb;11(2):ZD09-ZD11. doi: 10.7860/JCDR/2017/23510.9212. Epub 2017 Feb 1. PMID: 28384987; PMCID: PMC5376901.
47. Chang PS, Yen TH, Huang CJ, Yen AM, Chen SL, Tsai AI. Clinical Orofacial Anomalies in Taiwanese Children under Age Six: a Study Based on the 1995-1997 National Dental Survey. *Biomed Res Int*. 2020 Jul 19;2020:2056340. doi: 10.1155/2020/2056340. PMID: 32766305; PMCID: PMC7387978.
48. Guttal KS, Naikmasur VG, Bhargava P, Bathi RJ. Frequency of developmental dental anomalies in the Indian population. *Eur J Dent*. 2010 Jul;4(3):263-9. PMID: 20613914; PMCID: PMC2897859.

49. Kapdan A, Kustarci A, Buldur B, Arslan D, Kapdan A. Dental anomalies in the primary dentition of Turkish children. *Eur J Dent.* 2012 Apr;6(2):178-83. PMID: 22509121; PMCID: PMC3327494.
50. Ravn JJ. Aplasia, supernumerary teeth and fused teeth in the primary dentition. An epidemiologic study. *Scand J Dent Res.* 1971;79(1):1-6. doi: 10.1111/j.1600-0722.1971.tb01986.x. PMID: 5292961.
51. Mohan RP, Verma S, Singh AK, Singh U. Double tooth in mandibular incisor region: a case report. *BMJ Case Rep.* 2013 Feb 20;2013:bcr2012008647. doi: 10.1136/bcr-2013-008647. PMID: 23429027; PMCID: PMC3604312.
52. Mohan RP, Verma S, Singh U, Agarwal N. Gemination. *BMJ Case Rep.* 2013 Nov 6;2013:bcr2013010277. doi: 10.1136/bcr-2013-010277. PMID: 24197807; PMCID: PMC3830388.
53. Sekerci A, Sisman Y, Yasa Y, Şahman H. Prevalence of fusion and germination in permanent teeth in Coppadocia region in Turkey. *Pakistan Oral and Dental Journal.* 2011;31(1):15-20.
54. G S, Jena A. Prevalence and Incidence of Gemination and Fusion in Maxillary Lateral Incisors in Odisha population and Related Case Report. *J Clin Diagn Res.* 2013 Oct;7(10):2326-9. doi: 10.7860/JCDR/2013/5677.3516. Epub 2013 Oct 5. PMID: 24298521; PMCID: PMC3843463.
55. Zhu M, Liu C, Ren S, Lin Z, Miao L, Sun W. Fusion of a supernumerary tooth to right mandibular second molar: a case report and literature review. *Int J Clin Exp Med.* 2015;8(8):11890-5.
56. Duncan K, Crawford PJ. Transposition and fusion in the primary dentition: report of case. *ASDC J Dent Child.* 1996 Sep-Oct;63(5):365-7. PMID: 8958352.
57. Favalli O, Webb M, Culp J. Bilateral twinning: report of case. *J Dent Child.* 1998;65(4):268-71, 230.
58. Hagman FT. Anomalies of form and number, fused primary teeth, a correlation of the dentitions. *J Dent Child.* 1988;55(5):359-61.
59. Guirguis M. Gli spazi della morte a Monte Sirai (Carbonia - Sardegna). Rituali e ideologie funerarie nella necropoli fenicia e punica (scavi 2005-2010). *Fastionline.* 2011;FOLD&R(230):1-32.
60. Fiammenghi CA. Le necropoli di Elea-Velia: qualche osservazione preliminare. In: Greco G, editor. *Elea-Velia Le nuove ricerche Atti del Convegno di Studi (Naples14 dicembre 2001).* Pozzuoli (NA): Centro Studi Magna Grecia; 2003. p. 49-61.
61. Cicala L. Osservazioni sulla necropoli romana di Porta Marina Sud a Velia. *La Parola del Passato Rivista di Studi Antichi.* 2018;73(1):197-203.
62. Sperduti A, Bondioli L, Craig O, Prowse T, Garnsey P. Bones, teeth, and history. In: Scheidel W, editor. *The science of Roman history: biology, climate and the future of the past.* Princeton University Press. 2018.
63. Bondioli L, Nava A, Rossi PF, Sperduti A. Diet and health in Central-Southern Italy during the Roman Imperial time. *ACTA IMEKO.* 2016;5(2):19.
64. Marciniak S, Prowse TL, Herring DA, Klunk J, Kuch M, Duggan AT, Bondioli L, Holmes EC, Poinar HN. *Plasmodium falciparum* malaria in 1st-2nd century CE southern Italy. *Curr Biol.* 2016 Dec 5;26(23):R1220-R1222. doi: 10.1016/j.cub.2016.10.016. PMID: 27923126.
65. Marciniak S, Prowse TL, Herring DA, Klunk J, Kuch M, Duggan AT, Bondioli L, Holmes EC, Poinar HN. *Plasmodium falciparum* malaria in 1st-2nd century CE southern Italy. *Curr Biol.* 2016 Dec 5;26(23):R1220-R1222. doi: 10.1016/j.cub.2016.10.016. PMID: 27923126.
66. Crowe F, Sperduti A, O'Connell TC, Craig OE, Kirsanow K, Germoni P, Macchiarelli R, Garnsey P, Bondioli L. Water-related occupations and diet in two Roman coastal communities (Italy, first to third century AD): correlation between stable carbon and nitrogen isotope values and auricular exostosis prevalence. *Am J Phys Anthropol.* 2010 Jul;142(3):355-66. doi: 10.1002/ajpa.21229. PMID: 20014179.
67. Sperduti A, Bondioli L, Garnsey P. Skeletal evidence for occupational structure at the coastal towns of Portus and Velia (1st-3rd c. A.D.). In: Schrüfer-Kolb I, editor. *More than just numbers? The role of science in Roman Archaeology.* Portsmouth: J Rom Archaeo; 2012. p. 53-70.
68. Craig OE, Biazzo M, O'Connell TC, Garnsey P, Martinez-Labarga C, Lelli R, Salvadei L, Tartaglia G, Nava A, Renò L, Fiammenghi A, Rickards O, Bondioli L. Stable isotopic evidence for diet at the Imperial Roman coastal site of Velia (1st and 2nd centuries AD) in Southern Italy. *Am J Phys Anthropol.* 2009 Aug;139(4):572-83. doi: 10.1002/ajpa.21021. PMID: 19280672.
69. Stark RJ, Emery MV, Schwarcz H, Sperduti A, Bondioli L, Craig OE, et al. Imperial Roman mobility and migration at Velia (1st to 2nd c. CE) in southern Italy. *J Archaeol Sci: Reports.* 2020;30:102217.
70. Rovina D. L'insediamento costiero di Santa Filitica a Sorso tra età romana e alto medioevo. In: Soddu A, editor. *Castelsardo Novecento anni di storia.* Pisa: Carocci editore; 2007. p. 111-23.
71. Garau E, Rovina D, Sanna L, Testone V, Longo V. Il sito tardoromano-altomedievale di Santa Filitica (Sorso-SS): nuove ricerche. In: Martorelli R, Piras A, Spanu PG, editors. *Isole e terraferma nel primo Cristianesimo Identità locale ed interscambi culturali, religiosi e produttivi XI Congresso Nazionale di Archeologia Cristiana (Cagliari-Sant'Antioco, 23-27 settembre 2014).* Cagliari: Studi



- e Ricerche di Cultura Religiosa, Nuova Serie, VIII, vol. II; 2015. p. 951–60.
72. Rovina D. L'insediamento altomedievale di Santa Filitica (Sorso - SS): interventi 1980-1989. Relazione preliminare. *Archeologia Medievale*. 1999;26:179–216.
  73. Fentress E, Goodson C, Maiuro M, editors. *Villa Magna: an imperial estate and its legacies: excavations 2006-10*. London: British School at Rome; 2016. 516 p.
  74. Candilio F, Cox S, Nitsch E. The human remains. In: Fentress E, Goodson C, Maiuro M, editors. *Villa Magna: an imperial estate and its legacies: excavations 2006-10*. London: British School at Rome; 2016. p. 279–401; 435–8.
  75. Antonio ML, Gao Z, Moots HM, Lucci M, Candilio F, Sawyer S, et al. Ancient Rome: A genetic crossroads of Europe and the Mediterranean. *Science*. 2019 Nov 8;366(6466):708–14.
  76. Kinkopf KM, Agarwal SC, Goodson C, Beauchesne PD, Trombley TM, Candilio F, et al. Economic access influences degenerative spine disease outcomes at rural Late Medieval Villamagna (Lazio, IT). *Am J Phys Anthropol*. 2020;ajpa.24180.
  77. Trombley TM, Agarwal SC, Beauchesne PD, Goodson C, Candilio F, Coppa A, et al. Making sense of medieval mouths: Investigating sex differences of dental pathological lesions in a late medieval Italian community. *Am J Phys Anthropol*. 2019;169(2):253–69.
  78. Ubelaker DH. *Human skeletal remains: excavation, analysis, interpretation*. Washington: Taraxacum; 1989. 172 p.
  79. Stloukal M, Hanáková H. Die Länge der Längsknochen Altslawischer Bevölkerungen – Unter besonderer Berücksichtigung Wachstumsfragen. *Homo*. 1978;29:53–69.
  80. Aguiló L, Gandia JL, Cibrian R, Catala M. Primary double teeth. A retrospective clinical study of their morphological characteristics and associated anomalies. *Int J Paediatr Dent*. 1999 Sep;9(3):175–83. doi: 10.1046/j.1365-263x.1999.00131.x. PMID: 10815574.
  81. Kariya PB, Shah S, Buch A, Shag RB. Bilateral Fusion of Deciduous Teeth in Mandibular Arch with the Absence of Permanent Successor: Concomitant Fusio-agenesia. *JSAAPD*. 2021;3(2):80–3.
  82. Mehta N, Konarski A, Rooney P, Chandrasekar C. Leiomyosarcoma of the ischioanal fossa: report of a novel sphincter and sciatic nerve sparing simultaneous trans-abdominal and trans-gluteal resection and review of the literature. *J Surg Case Rep*. 2015 Mar 10;2015(3):rjv016. doi: 10.1093/jscr/rjv016. PMID: 25759172; PMCID: PMC4354263.
  83. Mehta V. Bilateral Fusion in Mandibular Primary Anterior Teeth: Report of a Rare Case with a Brief Review of Literature. *Dent Open J*. 2017;4(1):10–2.
  84. Brook AH, Winter GB. Double teeth. A retrospective study of 'geminated' and 'fused' teeth in children. *Br Dent J*. 1970 Aug 4;129(3):123–30. doi: 10.1038/sj.bdj.4802533. PMID: 5272471.
  85. Jain AA, Yeluri R, Munshi AK. Gemination Or Fusion? A Diagnostic Dilemma. *Dentistry*. 2014;04(02):1–2.
  86. Nandini DB, Deepak BS, Selvamani M, Puneeth HK. Diagnostic dilemma of a double tooth: a rare case report and review. *J Clin Diagn Res*. 2014 Jan;8(1):271–2. doi: 10.7860/JCDR/2014/6556.3928. Epub 2014 Jan 12. PMID: 24596793; PMCID: PMC3939503.
  87. Shilpa G, Gokhale N, Mallineni SK, Nuvvula S. Prevalence of dental anomalies in deciduous dentition and its association with succedaneous dentition: A cross-sectional study of 4180 South Indian children. *J Indian Soc Pedod Prev Dent*. 2017 Jan-Mar;35(1):56–62. doi: 10.4103/0970-4388.199228. PMID: 28139484.
  88. Milazzo A, Alexander SA. Fusion, gemination, oligodontia, and taurodontism. *J Pedod*. 1982 Winter;6(2):194–9. PMID: 6951989.
  89. Collina F, Conti S, Menetti M, Scheda L, Sorrentino R, Benazzi S. The first archaeological case of permanent teeth fusion in Europe. *Int J Osteoarch*. 2021;0a.2963.
  90. Phillips ELW, Irish JD, Antoine D. Ancient Anomalies: Twinned and supernumerary incisors in a medieval Nubian. *Int J Osteoarchaeol Dent Anth J*. 2021;0a.2954.
  91. Sublimi Saponetti S, Bertini E, Sassanelli G. Gli abitanti di una comunità rurale: profilo bio-antropologico degli individui sepolti nella chiesa del Barsento di Noci. In: Pellegrino E, editor. *Il complesso di Barsento a Noci*. Bari: Sagraf Editrice; 2020. p. 207–19.
  92. Gellin ME. The distribution of anomalies of primary anterior teeth and their effect on the permanent successors. *Dental Clinics of North America*. 1984;28(1):69–80.
  93. Benazzi S, Buti L, Franzo L, Kullmer O, Winzen O, Gruppioni G. Report of three fused primary human teeth in an archaeological material. *Int J Osteoarch*. 2010;20(4):481–5.
  94. Tritsaroli P. A Case of Dental Fusion in Primary Dentition from Late Bronze Age Greece. *Balk J Dent Med*. 2018;22(2):102–5.
  95. Silva AM, Silva AL. Unilateral Fusion of Two Primary Mandibular Teeth: Report of a Portuguese Archeological Case. *Dent Anth J*. 2007;20(1):16–8.
  96. Mays S. The human remains. In: Mays S, Harding C, Heighway CM, editors. *The churchyard (Wharram: a*

- study of settlement on the Yorkshire Wolds). York, UK: Department of Archaeology, University of York; 2007. p. 470. (York University archaeological publications).
97. Anderson S. The human remains from Caister-on-Sea. England: Historic Building and Monuments Commission for England; 1990 p. 98. (Ancient Monuments Laboratory). Report No.: 9/91.
98. Darling MJ, Gurney D. Caister-on-Sea Excavations by Charles Green, 1951-55. Norfolk: F Arch Div, Norfolk Museum Service; 1993. 311 p. (East Anglian Archaeology Report).
99. Padgett BD. Triple Fusion in the Primary Dentition from Law's Site, Alabama (1MS100): A Case Report. *Dent Anth J.* 2010;23(1):25-7.
100. Smith MO, Wojcinski MC. Anomalous double-crowned primary teeth from Pre-Columbian Tennessee: A meta-analysis of hunter-gatherer and agriculturalist samples. *Int J Paleopathol.* 2011 Dec;1(3-4):173-183. doi: 10.1016/j.ijpp.2012.02.008. Epub 2012 Mar 14. PMID: 29539333.
101. Sciulli PW. Evolution of the dentition in prehistoric Ohio Valley Native Americans: II. Morphology of the deciduous dentition. *Am J Phys Anthropol.* 1998 Jun;106(2):189-205. doi: 10.1002/(SICI)1096-8644(199806)106:2<189::AID-AJPA6>3.0.CO;2-L. PMID: 9637183.
102. Tasa GL. A Unilateral Connate Incisor in a ca. 2,000 Year Old Mandible from the Middle Columbia River Plateau. *Dent Anth J.* 1998;13(1):9-12.
103. Berryman HE. The Averbuch Skeletal Series: A Study of Biological and Social Stress at a Late Mississippian Period Site from Middle Tennessee. 1981;222.
104. Stevenson DR. Prevalence rate of double teeth in deciduous dentition at Averbuch (40DV60). *Tennessee Anthropologist.* 1985;X(2):134-55.
105. Palkovich AM. Pueblo population and society: the Arroyo Hondo skeletal and mortuary remains. 1st ed. Santa Fe, N.M: School of American Research Press; 1980. 194 p. (Arroyo Hondo archaeological series).
106. Drusini AG, Swindler DR. Connate Incisors in a Pre-Columbian Mandible from Nasca, Peru. *DAJ.* 1994;9(1):11-11.
107. Yamamoto M. Dental anomalies in the deciduous teeth of Edo Japanese. *J Ant Soc Nip.* 1989;97(3):389-92.