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RESEARCH

Stabbed to death: an osteobiography example of violence among Longobards (Povegliano Veronese, Italy, 6th-8th c CE)

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Abstract

Here we report the reconstruction of the osteobiography of an adult male buried in the Longobard cemetery of Povegliano Veronese (Northern Italy, late 6th – early 8th century CE), who shows signs of interpersonal violence. The palaeopathological investigation reveals sharp force traumas on the body of the fourth lumbar vertebra and on two right ribs. The absence of signs of healing or bone remodelling indicates that the defects were *perimortem*. The injuries probably affected vital organs, leading to death. Further macroscopic observations of the skeleton suggest horseback-riding activity. Strontium isotope data from tooth enamel indicate a non-local origin of the individual. X-ray and CT scan acquisition and Scanning Electron Microscopy analyses were performed to investigate the bone defects. His osteobiography was interpreted and contextualised in the complex socio-political scenario of post-classical Italy. The results document that he spent his childhood outside the Povegliano Veronese area, that during his life he was likely a horseback rider active in battle, but that his violent death did not happen during warfare/battle. This multi-layered approach, supported by archaeological information, osteological investigation, biomolecular analysis, and virtual imagery, allowed for the extensive reconstruction of an individual's life history.

Keywords Physical anthropology · Early Middle Ages · Strontium isotopes · Migration · Interpersonal violence · Horseback rider

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Introduction

The *Historia Langobardorum* by Paul the Deacon (8th c CE) covers the story of the Longobards, from their mythical origins to their migration from eastern Europe to Italy and the end of their hegemony in the Italian Peninsula (6th-8th c CE). This critical historic document contains wide information about the lives of the Longobard kings and the events of others high-ranking people from this population. However, less is known about the ordinary people that migrated from the Roman province of Pannonia (Hungary) and eastern Austria which inhabited Italy (6th-8th c CE, Rotili 2010; Brogiolo and Chavarria Arnau 2007). Interpretation of skeletal trauma in bioarchaeology is challenging but helps in defining life conditions and habits of past populations (in general: Thorpe 2003; Knüsel and Smith 2013; Grauer and Miller 2017; specifically for the Middle Ages: Rubini and Zaio 2011; Tumler et al. 2021). Although it is rare to have life records of ordinary individuals from the past (Robb et al. 2019), it is also true that the investigation of a single individual from skeletal remains may create bias in the interpretation of an osteobiography (Hosek and Robb 2019). The bio-social consequences of migration, micro and large-scale historical processes, will be applied to shed light on an individual's life from this period of time to overcome these possible biases.

In this paper, we investigate the violent death of a male found in tomb 19 (hereafter referred to as T19) excavated from the Early Medieval cemetery of Povegliano Veronese (Verona, Northern Italy; Fig. 1a-b). According to the archaeological reconstruction, it was a cemetery of Longobard culture (Giostra 2014; Bruno and Giostra 2012). The most striking features of the skeleton of T19 are the traumatic defects observed in the rib cage and on the lumbar region of the vertebral column.

The aim of the paper is twofold: i) to reconstruct the osteobiography of T19 through a multi-layered analysis; ii) to interpret and contextualise the signs of bladed tool injuries visible on a vertebral body and two ribs, which likely led to his death. Whereas Longobards are widely osteologically

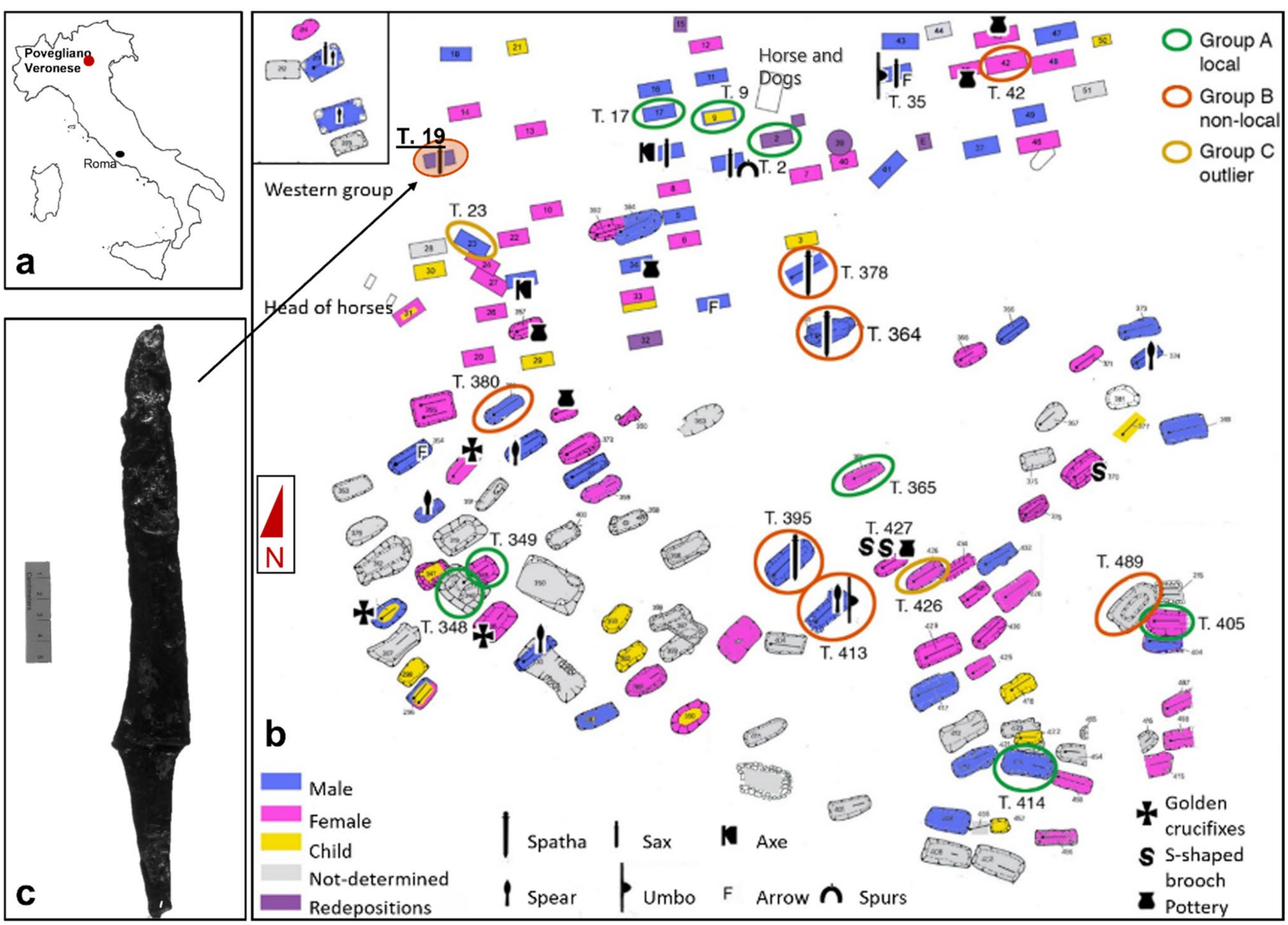

Fig. 1 The cemetery of Povegliano Veronese. **a**) the site's location in northern Italy; **b**) the plan of the cemetery (modified from Giostra 2014). T19 is shaded. **c**) The *Scramasax* found in the burial (picture by C. Giostra)

investigated as a whole population (e.g. Knipper et al. 2014; Alt et al. 2014; Francisci et al. 2020), this work will attempt to address the life of a single individual in a way that is not readily attainable through written sources.

Material

The Early Medieval cemetery of Povegliano Veronese was discovered in 1985 (Giostra 2014; Bruno and Giostra 2012). The archaeological campaigns (1985–86 and 1992–93) brought to light 150 single burials and 14 multiple burials (Fig. 1b). The burials are organised in lines, with the presence of the so-called *Tottenbret* (i.e., wood-line burials) and ritual customs such as the burial of an acephalous horse and two dogs, and the golden S-shaped buckles in female burials associated with weapons of Germanic origin in male ones. These features suggest that the cemetery is most likely associated with the first generation of Germanics/Longobards who arrived in Italy (Giostra 2014). The site can be bracketed between the end of the 6th and the beginning of the 8th c CE (Giostra 2014; see Supplementary Note 1).

An osteological investigation allowed us to identify 55 sub-adults and 169 adults (45 males, 44 females, and 80 of indeterminate sex). The high number of indeterminate adults is caused by the multiple burials, among which are commingled remains (Micarelli 2020).

Previous research on Degenerative Joint Disease (DJD) in this population showed that males were more heavily involved in strenuous biomechanical activities than females (Micarelli 2020). Analysis of the adult individuals (20–49 years old) highlighted a probable division of daily tasks between the sexes. Rates of DJD recorded in burials from the first phase of use of the cemetery (i.e., Longobards migration period, the second half of the 6th c—beginning of the 7th c CE; Giostra 2014) were much higher than those found in burials of the following phases (i.e., sedentary Longobards, beginning of the 7th c CE—beginning of the 8th c CE; Giostra 2014). Specifically, DJD analysis has revealed differences in the lower limbs between migrant Longobard males and later sedentary ones (Micarelli 2020). Studies on metabolic diseases have shown that part of the population suffered from vitamin C deficiency (Panella 2018). Specifically, individuals from the first phase of use of the cemetery show high frequencies of scurvy (Panella 2018). Finally, a recent study on gastrointestinal infections in Italy during the Longobard phase, which included Povegliano cemetery remains, did not reveal the presence of these health issues (Ledger et al. 2021).

The burial lies in a marginal position with a limited grave goods assemblage (i.e., *Scramasax*). Despite the incomplete archaeological data, due to the bad state of preservation of this area of the cemetery, T19 tomb's features suggest that he was placed in the cemetery during the late 6th and early 7th (Giostra 2014; Bruno and Giostra 2012; Micarelli 2020). The body was placed in a burial pit, oriented east–west, with the head to the west. The individual was inhumed with only a *Scramasax*, a short single-edged sword (21 cm blade, 8 cm handle, for a total of 29 cm; Fig. 1c) placed alongside the left femur. Usually, short *Scramasax* like this one does not date beyond the beginning of the seventh century (De Marchi and Possenti 1998). So, the length of the *Scramasax* from T19, along with the position and the typology of the tomb, dates the burial to the first phase of the cemetery, suggesting that T19 belongs to the group of migrated Longobards.

As displayed in Fig. 2a, the skeleton is almost complete; however, some bones are in a poor state of preservation. The surface of the bones, especially the cranium, is severely affected by taphonomic processes, such as root etching and erosion (following Klaus and Lynnerup 2019). The bodies of thoracic vertebrae are not preserved, and the ribs are fragmented.

Methods

Biological profile and pathological assessment

Based on the standard methods common in anthropology, summarised in White et al. 2011, we reconstruct the biological profile (determination of sex and estimation of the age-at-death; White et al. 2011). Following White et al. (2011), measurements were taken with the osteometric board, and the stature was estimated based on the length of the left femur and the right humerus (Sjøvold 1990).

As part of the life history reconstruction of T19, a macroscopic pathological assessment was carried out on the entire skeleton, following Zampetti et al. (2016) for Degenerative Joint Disease (DJD); Cardoso and Henderson (2010), Mariotti et al. (2007) and Djukic et al. (2018) for entheseal changes, and Lovell (1997) and Redfern and Roberts (2019) for trauma. Dental pathologies and lesions were observed using methods synthesised by Buikstra and Ubelaker (1994). Estimating age at Linear Enamel Hhypoplasia (LEH) formation was performed using the standard of Goodman and Rose (1990); measurements were taken with digital callipers and are reported in Supplementary Table S2.

Isotopic assessment

To explore the early life of T19, the strontium isotope ratio has been measured on 10 mg of dental enamel collected from T19's mandibular incisor (LI1), which forms between 0 and 4–5 years of age (AlQahtani et al. 2010). Samples were digested in 1 ml concentrated ultrapure HCl, then evaporated to dryness and redissolved in 2 ml 2 M ultrapure HCl. Sr was separated from the matrix onto a preconditioned resin column with 2 mL of AG50W-X12 (200 – 400 mesh) following the procedure of Chao-Feng et al. (2014). Analyses were carried out at the Department of Earth Marine and Environmental Sciences at the University of North Carolina at Chapel Hill (USA). Values for ^{87}Sr/^{86}Sr are reported relative to 0.710250 for standard NBS-987. Strontium ratios are related to the geological signature in which the organism grows, so it is paramount to have local referential values to assess its origin. Therefore, to evaluate T19 possible in-life movement, it was used the already published strontium data from Povegliano Veronese cemetery (Francisci et al. 2020). Further multi-tissue stable carbon, nitrogen, and oxygen isotope analyses are available for a subset of the Povegliano Veronese population, including T19 (Marinato 2016). The data were integrated into the life-history reconstruction of this individual to evaluate dietary intra-life variations. A summary of all the isotope analyses performed on this individual and the comparative sample from Povegliano Veronese cemetery is reported in Supplementary Table S3.

Scanning Electron Microscope of the surface of the sternal end of the 9th/10th right rib

With the aim of investigating the surface of the sternal end of the 9th/10th right rib (Greenfield 1990) and the possible presence of physical traces of the weapon (Bartelink et al. 2001), a Scanning Electron Microscope (SEM) analysis was conducted. The investigation was performed in three different sections of the defect, and the results are reported in Supplementary Fig. S1.

Tomographic acquisition of the 4th Lumbar vertebra

A CT scan of the 4th Lumbar vertebra was performed using a "*SkyScan 1176*" micro-CT scanner (Bruker-microCT, Kontich, Belgium), with a resolution of 17 µm, source voltage 90 K.V. and source current 278 µA, the interslice distance is 0.07 mm. Supplementary Fig. S2 reports six slices of the CT scan.

Results

Biological profile and pathological assessment

The skeleton corresponds to that of an adult male, with an estimated age between 40 and 50 years. He reached a stature of 172.4 cm. The palaeopathological assessment showed diffuse Degenerative Joint Disease (DJD). They were recorded on both hips, the right knee, and the left shoulder, as reported in Supplementary Note 2. In addition, the vertebrae are severely affected by osteoarthrosis, especially the lumbar region (a list of the pathological bones scored is in Supplementary Note 2). In the vertebral column, DJD processes are more severe on the right side of the body, as shown by the considerable osteophytes

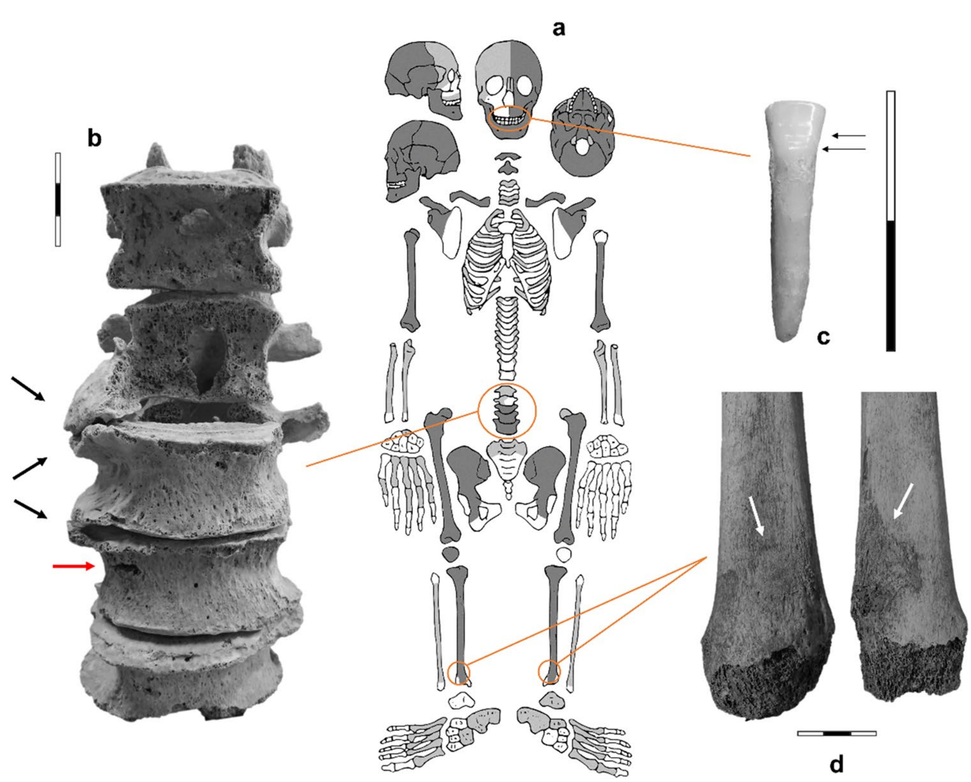

Fig. 2 T19 skeleton and pathologies. **a**) The bones present are grey-coloured. Dark grey: bone in a good state of preservation; light grey: bones in a bad state of preservation (taphonomic changes) **b**) Lumbar vertebrae, frontal view. Black arrows indicate the osteophytes on the right side of the vertebral body of L2 and L3. The red arrow indicates the perimortem trauma on L4. **c**) RI2. Black arrows indicate the LEH. **d**) Diffuse cortical irregularity on the posterior distal shaft of both tibiae associated with diffuse porosity, indicated by white arrows

in the L2 (measuring: 2.5 × 1.8 cm) and L3 (measuring: 2.5 × 1.1 cm, Fig. 2b) correlated with the Schmorl's node on the lower surface of the L3 body.

T19 shows entheseal changes throughout the skeleton typical of an older male. The most distinct entheseal signs consist of the costoclavicular ligament on both clavicles with an osteolytic enthesopathy and the superficial tendons of flexor muscles on hand phalanges. Moreover, the entheseal changes highlight an isolated and irregular bone protrusion on the posterior distal shaft of the right femur. Specifically, the injury is visible at the middle third of the medial lip of the *linea aspera*, measuring superior-inferior 4.3 cm and anterior–posterior 1.7 cm (Supplementary Note 3). This site corresponds with the insertion of the adductor longus muscle, which is primarily involved in the adduction and lateral rotation of the thigh (Kahle et al. 2004). This lesion can be recognised as an inflammatory ossification of muscle, defined as post-traumatic myositis ossificans (Savvidou et al. 2021; Walczak et al. 2015). The differential analysis of these features is reported in Supplementary Note 3. This bone formation is associated with muscle injury and repetitive minor trauma, which involves only the soft tissue (Mays 2010; Rodríguez-Martín 2006). Following the current medical literature, he likely suffered from this condition for at least several months (Savvidou et al. 2021).

Two bilateral cortical irregularities were recorded on the posterior distal shaft of both tibiae. The areas of interest present new bone deposition completely incorporated into the bone surface in the form of remodelled lamellar bone. These areas are also covered by diffuse porosity. No muscular attachment is present in this tibia region (Fig. 2d).

During his life, T19 suffered repeated dental diseases such as extreme wear, tooth loss and abscesses. The assessment of teeth, state of preservation, evaluation of wearing, and possible pathologies are reported in Supplementary Table S1. Moderate Linear Enamel Hypoplasia (LEH) observed in two anterior mandibular teeth (RI2 and LI2) reveals at least three intervals of interrupted growth between 2 and 4 years of age (see Supplementary Table S2; Fig. 2c). On the right mandibular condyle is recorded the presence of DJD.

Three traumatic injuries were found: one on the ventral aspect of the body of L4 and two on two right ribs (Fig. 3b-c-d). Given the fragmentary nature of the ribs, it is not possible to assess their exact anatomical position. However, their morphology suggests they derive from the lower ribs, likely the 9th and 10th. The two instances of sharp force trauma measure 8 mm in length (Fig. 3b-c). The surfaces of the cut edges are flat, showing fine polishing. These injuries are linear, without irregularities along the line of the injury and can be distinctively recognisable as sharp cut marks without signs of the shattering of the bone surfaces (Fig. 3b2).

The sharp trauma on the right half of the ventral portion of the body L4 measures 14 mm in length, 2 mm in height on the right edge and 3 mm on the left. It is worth stressing that the shape of the defect recalls the section of a blade, such as a knife or a sword (Enicker et al. 2015) (Fig. 3d). The edges of all injuries are well-defined, showing the same colour of the cortical bone surface and in the cut, without signs of bone remodelling, suggesting perimortem trauma (as reported in the literature Lovell 1997; Redfern and Roberts 2019; Wedel and Galloway 2014) (Fig. 3d; Supplementary Fig. S2). There are no other injuries on the other vertebrae, and the absence of many vertebral bodies makes it impossible to infer if other column parts were injured.

Isotopic assessment

T19's strontium isotope ratio measured in the dental enamel is 0.70999 ± 0.0007 (Fig. 4; Supplementary Table S3). Already published comparative strontium data from soil (mean 0.70861; n = 4) and animal (mean 0.70898; n = 6) samples are available from Povegliano Veronese cemetery and used to assess the local range (Francisci et al. 2020) (Fig. 4; Supplementary Table S3). Strontium ratios of human dental enamel from a selection of the Povegliano Veronese population range from 0.70836 to 0.71280 (mean 0.70913; n = 39), identifying three subgroups according to the local strontium signature (see discussion in Francisci et al. 2020) (Fig. 4). T19 strontium ratio falls outside Povegliano Veronese local range values indicating a non-local origin (Fig. 4; for an overview of the isotopic analyses performed on the cemetery and T19, see Supplementary Table S3).

Discussion

Biological profile and pathological assessment

T19 was a robust individual. His stature has been estimated at 172.4 cm, slightly higher than the average of the other males buried in Povegliano Veronese (170.3 cm; Micarelli 2020). Compared to other Barbaric migrant populations from the first phase of occupation of Italy (late 6th—early 7th c CE), his stature is higher than that of the males from Campochiaro di Vicenne (166–169 cm, (Belcastro et al. 2001), and it is slightly lower than the average from Collegno (173.6 cm, Bartoli and Bedini 2004).

His life was characterised by high biomechanical loading, as suggested by the analysis of entheseal change and osteological measurements (i.e., lengths, diameters, and circumferences of long bones, Micarelli 2020). T19's bones show entheseal changes characteristic for an older male, suggesting that he was physically active during his life. The intense biomechanical stress and heavy physical activity, even from a young age, may be confirmed in the presence of Schmorl's node on L3 (Larsen 1997; Dar et al. 2010). As reported by WHO (2003) and clinical literature (O'Neill et al. 1999),

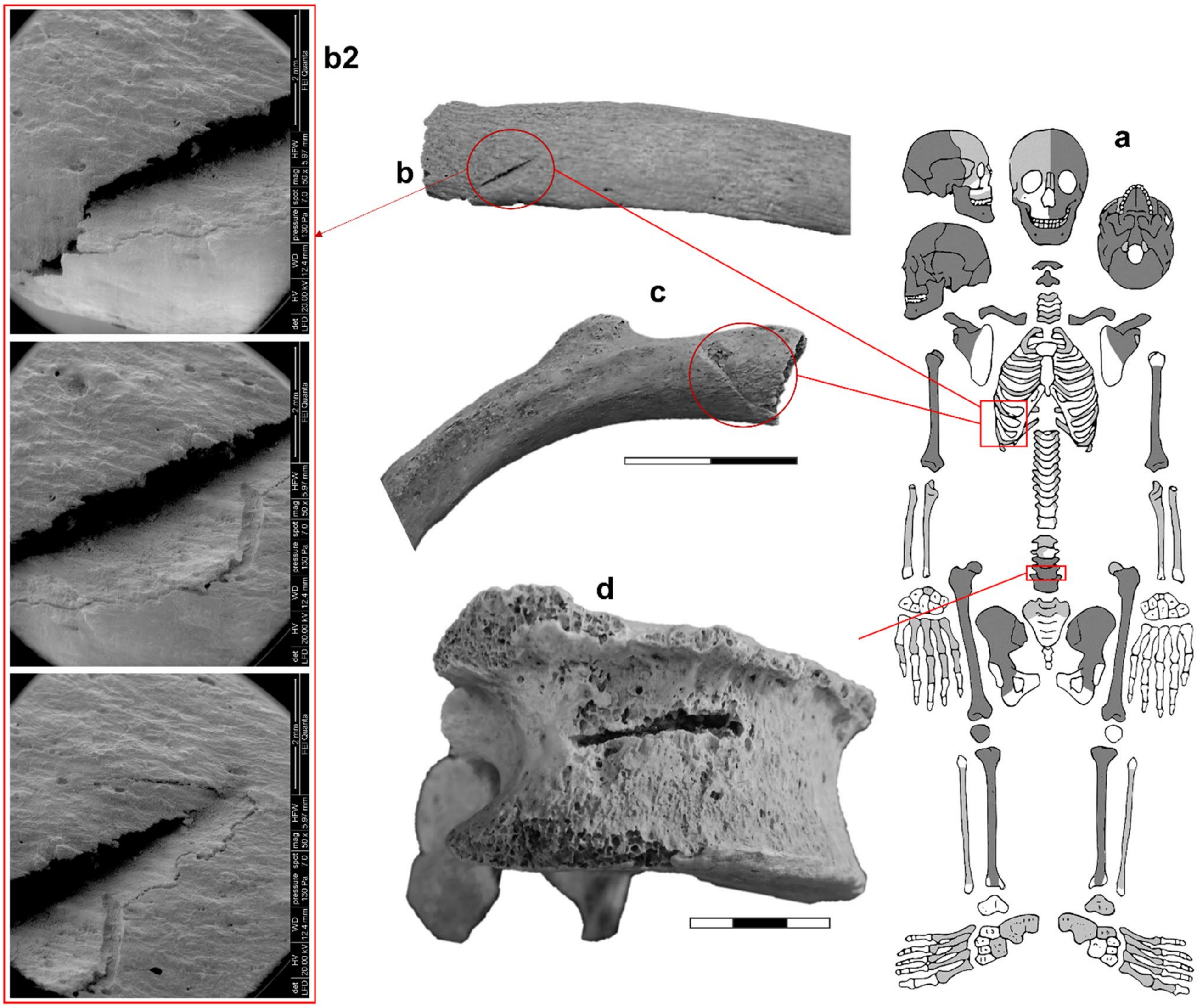

Fig. 3 T19 skeleton and perimortem traumas. **a**) The bones present are grey-coloured as in Fig. 2. **b**) The 9th/10th right rib, red circle indicates the sharp trauma on the sternal end. b2) SEM analyses of the sharp injury on the sternal end of the 9th/10th right rib. **c**) The 9th/10th right rib, with red circle indicating the sharp trauma on the neck. **d**) The sharp injury on the right half of the ventral portion of the vertebral body

joint diseases, osteoarthrosis, and, in general, spinal disorders are causes of low back pain affecting millions of people globally. Given the T19 skeletal condition, we may hypothesise he suffered from low back pain.

Horseback riding

The most distinct evidence of activity in the T19 skeleton might be related to horseback riding. Differential diagnosis and literature research on skeletal markers on femurs, tibiae and vertebrae caused by horseback riding are reported in Supplementary Table S4. Bilateral entheseal changes on the lower limbs and biomechanical stresses on the vertebral column support this hypothesis. However, life as a horseback rider had some associated risks. Even if there are no signs of bone fracture, the bony projection on the medial lip of the *linea aspera* can be recognised as a myositis ossificans of the adductor muscles and with traumatic origin. Adductor muscles usually are severely stressed during horseback riding (Enicker et al. 2015), and entheseal changes are common among riders (Walczak et al. 2015). During his life, T19 may have experienced a progressively reduced capacity for locomotion with consequent stiffness and pain in the movements of the lower limbs (Walczak et al. 2015). The bilateral cortical irregularity recorded on the posterior distal shaft of both tibiae associated with diffuse porosity can be related to hypervascularity. Repeated biomechanical/traumatic stress on the posterior distal shaft of both tibiae may have caused the recurrent periosteal

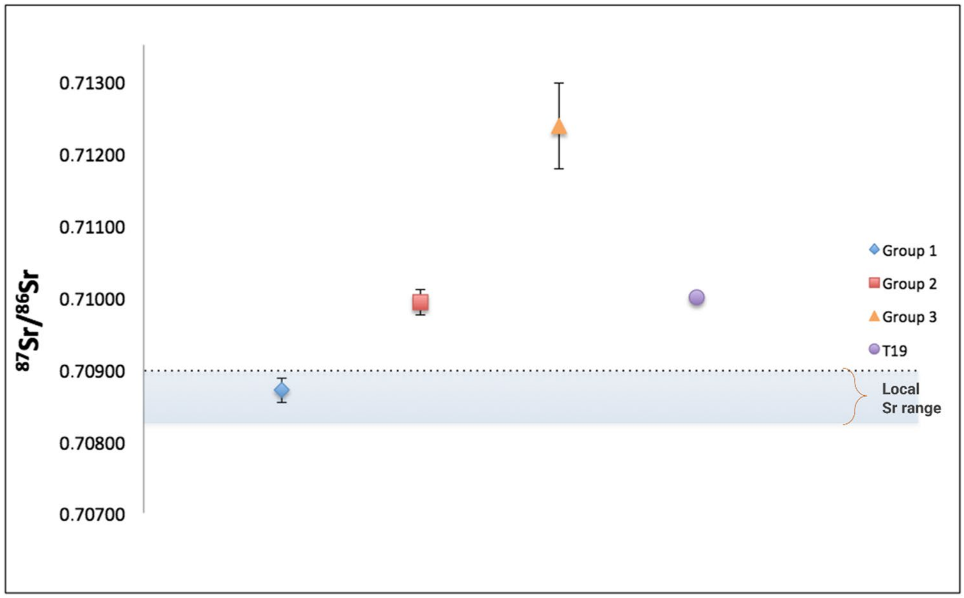

Fig. 4 $^{87}Sr/^{86}Sr$ measured in the dental enamel of T19 in relation to mean strontium values measured for the three sub-groups identified at Povegliano Veronese (Francisci et al. 2020): Group 1 = autochthonous (N = 27); Group 2 = allochthonous (N = 9); Group 3 = outliers (N = 2). The grey area corresponds to the strontium local range calculated as ± 2sd of the mean soil values. The dashed line represents the mean Sr ratio calculated on the animal samples only (Francisci et al. 2020).

reaction. So, these lesions may be recognised as trauma-related periostosis resulting from a chronic insult to bone (Roberts 2019). It is, however, important to note that the debate on the actual reliability of skeletal markers, which have been widely used in the literature, is still open. For instance, some of these traits could be associated solely with the age of the individual (i.e., vertebral osteophytes; Jurmain et al. 2012).

Diet-related disorders

The individual T19 shows evidence of metabolic stresses in the formation of Linear Enamel Hypoplasia observed on the mandibular teeth. The specific aetiology of LEH is still debated, but it is generally accepted that it can result from dietary deficiencies, infectious disease, intoxication, metabolic disorders, and parasite infestations (Cares Henriquez and Oxenham 2019). If he had suffered any other diet-related disorder (i.e., rickets, iron deficiency, scurvy) during childhood and adolescence this is not visible in the preserved skeletal remains, contrary to what was evaluated for scurvy in the rest of the individuals in the cemetery from the first phase (Panella 2018).

The observed dental pathologies would not have reduced his capacity to eat. Despite the severity of his dental diseases, these might have been considered tolerable, as they were common among people of his age in the medieval period (Trombley et al. 2019; Bertilsson et al. 2022). Dental problems in older people would have been identified as part of the ordinary life course. The skeletal sample from Povegliano Veronese shows a high frequency of caries and tooth losses, with only sporadic cases of abscesses (Di Giannantonio 2017; Micarelli et al. 2018a). This seems to be part of a pattern highlighted by Kiszely and Kiszely (1969) for the Longobards from northern European regions. These populations, with a diet consisting mainly of meat, would have been affected by high frequencies of caries once they experienced a sedentary life in Italy and started eating especially cereal products (Kiszely and Kiszely 1969).

The isotopic background

T19's strontium signature measured in the dental enamel collected from T19's mandibular lateral incisor is not consistent with either value from the local geological background, or the individuals analysed at Povegliano Veronese and marked as autochthonous (born and lived in Povegliano; Francisci et al. 2020) (Fig. 4). Instead, T19's strontium ratio matches with the values of other 9 allochthonous individuals (non-local people who had moved to Povegliano), dated to the early phases of use of the cemetery (Francisci et al. 2020; Fig. 1b and Fig. 4). For this group, the region of Pannonia, not far from Lake Balaton in modern Hungary, has been proposed as a possible area of origin (see discussion in Francisci et al. 2020). This area shows strontium ratios consistent with the allochthonous value range (Alt et al. 2014). As T19, this group of non-local individuals is ascribed to the first phase of occupation of the cemetery (Francisci et al. 2020). Then, we may assume the same scenario for T19. However, a similar value range is also recorded in an area along the Adige valley in the same region (Cavazzuti et al. 2019). Therefore, the available strontium ratios and the archaeological and historical background do not allow for assessing short or long-range mobility. Indeed, it could be stated that he was a non-local individual.

Already available multi-tissue stable carbon, nitrogen, and oxygen isotope analysis on T19 (Marinato 2016) reveal an interesting scenario for his diet. $\delta^{13}C$ and $\delta^{15}N$ values measured in the bone collagen (-18.6‰ and 8.0‰, respectively) and dentin (-18.0‰ and 8.2‰, respectively) show a diet mainly based on C_3 plants, although with a relative contribution of C_4 crops; this pattern is attested at other Longobard sites in Italy (e.g., Marinato 2016; Iacumin et al. 2014; Riccomi et al. 2020). The lack of isotope data from animal and vegetal remains makes it difficult to refer to a local baseline. Still, foods consumed by T19 were likely mostly of terrestrial origin, with little if any contribution of aquatic/marine resources. The multi-tissue analysis indicates no dietary changes between childhood (tooth values) and adulthood (bone values). Overall, we can suggest that T19's diet was mostly consistent with that of the other individuals analysed, although the sample size is relatively small: only 11 individuals were analysed by Marinato (2016) out of the 224 unearthed at the cemetery (Supplementary Table S3). Unlike $\delta^{13}C$ and $\delta^{15}N$ of dentin and bone collagen, $\delta^{13}C$ and $\delta^{18}O$ measured in dental carbonates (from dental enamel representing early life) suggest that T19 might have had a different origin from the rest of the analysed individuals. The $\delta^{18}O$ of -7.7‰ is slightly discordant with the mean values obtained in the subset (mean values = -5.9 ± 1.8‰; n = 8) (Supplementary Table S3) and might relate to different water sources, at least during early life. The list of isotopic analyses (carbon, nitrogen, oxygen, and strontium isotopes) performed on the Povegliano Veronese population and T19 is reported in Supplementary Table S3.

Perimortem event

The last event of T19's life is an act of interpersonal violence, as testified by the signs of stabs visible on his skeleton. A single event likely caused all these traumatic injuries, namely blows delivered by a sharp metal weapon (sharp force trauma, similar to that reported by Mays 2010). We suggest that the assailant struck the victim at least once, up to three times, with the blade. A slashing action from anterior to posterior, without penetrating the ribcage, caused the external injury on the 9th/10th rib (Fig. 3a-b). Eventually, two further assaults allowed the blade to pass below the rib cage (marks on the ventral surface of the neck of the other rib and the vertebral body of L4; Fig. 3c). In our reconstruction, the abdominal stab hit once on the neck of the rib and once on L4, encountering on the way several internal organs of the abdominal cavity (injury on L4: muscles of the abdomen, rectum and ureter; injury on the neck of the rib: duodenum/intestines, liver) and blood vessels (abdominal aorta and, especially, inferior vena cava), causing death shortly after the injury (Okyere et al. 2019; Singh et al. 2004). The trauma pattern is consistent with ventro-dorsal direction stabbing injuries. The presence of injuries on the right side indicates several possible scenarios:

i) They were inflicted by a left-handed assailant (Knüsel and Smith 2013; Grauer and Miller 2017; Singh et al. 2004).
ii) T19 was lying on his back, and the assailant delivered the blows while standing on T19's right side.
iii) The assailant standing on the ground and wielding a weapon with a blade (e.g., a sword) struck T19 while on horseback. Notably, a very light handle characterised Longobard swords dating to the first phase in Italy. The aim was to shift the centre of gravity towards the tip. This type of manufacture can be explained by the desire to weigh in balancing the blade for more effective use also during combat on horseback (de Vingo 2010).

The absence of parry fractures on hands and forearms (Kimmerle and Baraybar 2008; Cattaneo et al. 2009; Byers 2016) might suggest that the man was hit by surprise and did not have the chance to defend himself or he was unable to defend himself due to incapacitation by external factors (e.g., with tied hands/upper limbs).

Identify the perimortem event

Identifying the bladed weapon type based on the mark left on the bones is challenging, with some exceptions for forensic cases (e.g., Love 2019). However, differences between sword marks and knife marks can be observed: "*swords produce cut marks that are deep, wide, with a straight kerf and damage on the sides of the mark, whereas knives produce shallow, narrow and often meandering kerfs and relatively little damage to the sides of the mark*" (Lewis 2008: p. 2005).

By analysing the sequence of CT scan slices (Supplementary Fig. S2), the presence or the lack of bone healing processes within the injury can be observed. Considering the position and the depth of the stab on the neck of the rib and the L4 vertebra, we can hypothesise that an elongated weapon was used. A set of weapons diffused during the Longobard phase in Italy is illustrated in Fig. 5a-c. Very common weapons in Early Medieval Italy were swords (Giuffra et al. 2015; Tumler et al. 2019). We can exclude the use of a spear. Spears, indeed, frequently show a central midrib that would possibly be visible on the section of the bone (Fig. 5a). Looking at the shape of the section of the blades and comparing them with the injury on L4, it is likely that the injuries on T19 skeleton came from a sword. The SEM investigation of the injury did not detect relevant metal traces that could be related to the weapon used.

As Walker (2001) suggested, reconstructing traumatic events requires considering injuries from a population perspective. It is essential to take into account biological variables, such as age-at-death and sex, and extrinsic factors related to the socio-cultural context. In Povegliano Veronese, there is no other evidence of interpersonal trauma (Micarelli 2020), and T19 is one of the very few individuals with artefacts related to warfare (Fig. 1b-c). As a result, we offer several hypotheses for this unusual artefactual evidence:

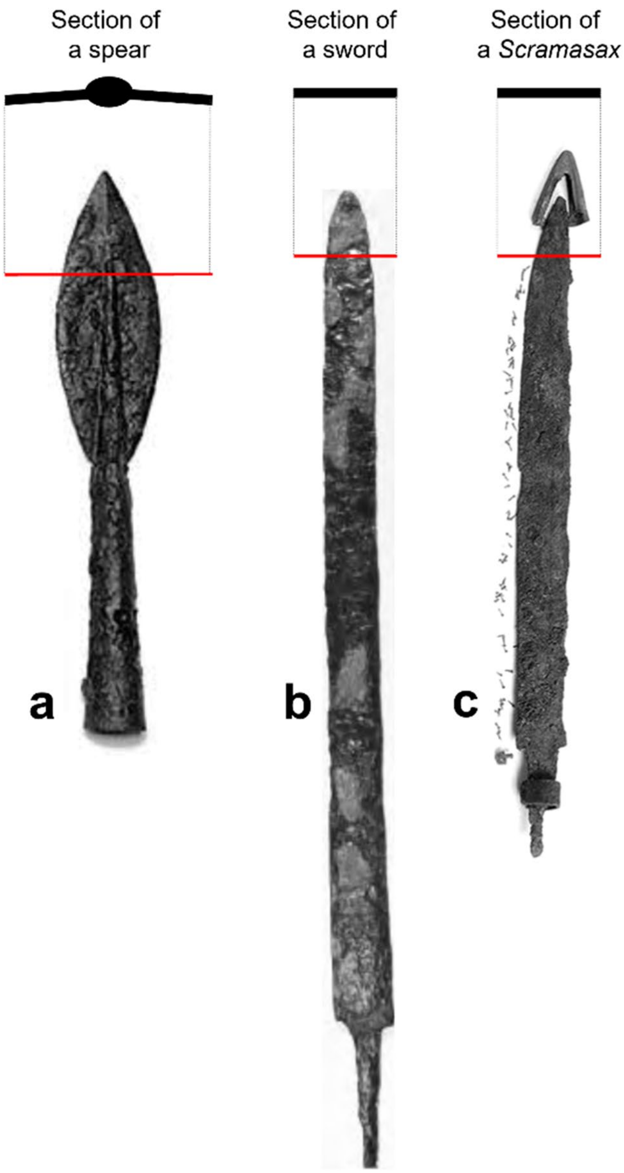

Fig. 5 Sections of a selection of Longobard blades: **a**) spear from the Longobard cemetery of Fara Olivana (second half of the 6th and 7th c Bergamo, Northern Italy; length: 28,3 cm, width: 2,8 cm; Brogiolo and Chavarria Arnau 2017); **b**) iron sword from the Longobard cemetery at Spilamberto (late 7th c, Modena, Northern Italy; length: 99.5 cm including blade and tang; width: 6,5 cm; de Vingo 2010); **c**) *Scramasax* with bronze elements of the scabbard (second half of the 7th c, Bergamo, Northern Italy; length: 34–40 cm, width: 3,4 cm; Brogiolo and Chavarria Arnau 2017)

i) *Judicial punishment*. Capital death is mentioned in a late collection of laws under King Rothari (643 CE) as a legitimate consequence for several violations, such as a premeditated assassination of the king, fleeing the kingdom, introducing an enemy into the country, and inciting a revolt among the soldiers (Azzara and Gasparri 2005). Unlike other eastern European Late-Antique – Early Middle Ages populations, such as the Avars (Wiltschke-Schrotta and Stadler 2005), for Longobards, we have no indication of how punishment was inflicted. However, T19 burial within the funerary area and the presence of a weapon as grave goods (i.e. *Scramasax*) attest to the fact that he was buried like the other community members. This pushes us to exclude the option of capital judicial punishment, which would have likely implied the absence of this kind of dedicated funerary ritual.

ii) *Warfare*. Among the Longobards, the *Arimani* ("freemen" from medieval Latin) were the men who could participate in warfare and had to be armed and able to fight with weapons (e.g., sword, *Scramasax*, spear) and own and ride a horse (Rotili 2010; Barbero and Frugoni 1994). Given the *Scramasax* in the burial, the robusticity and other bone markers related to equestrian practice, we may hypothesise that T19 was active in battle. However, his general health status (reduced capacity for locomotion) and elderly age led to exclude the hypothesis that he was involved in warfare in his late life.

iii) *Personal disputes*. The multiple injuries and their positions on the T19 skeleton seem to exceed the blade injuries necessary to kill someone. This can be referred to as overkill (Rubini and Zaio 2011; Karlsson 1998). Overkill and stabbing have been associated with strong emotional conflict (Silverman and Mukherjee 1987; Pereira et al. 2013). Excluding an eventual outsider assailant (e.g., during battles), a personal dispute between/among armed members of the same community is plausible. It is noteworthy that in the Povegliano Veronese cemetery, there were allochthonous males dated to the first phase of use of the funerary area and buried with a sword (Fig. 1c).

The absence of some vertebrae associated with the poor state of preservation of the thoracic vertebral bodies and L1 and L2, as well as other skeletal regions, did not allow us to observe the eventual presence of other traumatic injuries, specifically perimortem ones. This would have been useful to contextualise better the event that led to the death of T19. Our conclusions are based on the recorded bone marks, and we propose plausible hypotheses for the death of T19 based on the historical and archaeological context.

Conclusions

Following the Robb et al. (2019) assessment process, we summarise (in chronological order) the relevant osteobiographical events of the life history of T19 based on archaeological artefacts and osteological analyses.

- Via the isotopic investigation, T19 likely spent his childhood outside the Povegliano Veronese area. Nonetheless,

given the archaeological background, his tomb features, and his life reconstruction, he might have been involved in Longobard migrations to Italy. Moreover, evidence from the Longobard cemetery of Szólád (Pannonia, modern Hungary) shows similar burial customs as T19 (e.g., isotopic values, marginal position in the cemetery, and weapon in the grave good, Amorim et al. 2018)
- T19 survived childhood; he had no dietary changes between childhood and adulthood.
- Written sources lead us to propose that he might have been an *Arimanus*, a Longobard warrior trained for warfare, able to fight with weapons (e.g., sword, *Scramasax*, spear) and ride a horse. The osteological profile support that he was likely a horseback rider active in battle, at least during younger age.
- While we do not know the reasons for the event of interpersonal violence which caused his death, we exclude the relation with the migration/invasion processes. In the sixth century, Italy had already experienced several barbarian invasions and general warfare, so when the Longobards arrived on the Peninsula, the local population was already vexed. This does not exclude that there were battles between Barbaric and the local populations (Roberto 2012). Nevertheless, the absence of signs of *antemortem* traumas on the skeleton of T19 and the lack of battle injuries in the rest of the skeletal sample buried at Povegliano Veronese supports the exclusion of T19's death in relation to warfare.
- We can hypothesise that an elongated weapon was used, likely a sword, and that he was on horseback and the assailant was standing on the ground and holding a sword. However, considering T19 age at death, it is very unlikely that this happened during warfare/battle. Although the community had some experience treating extreme injuries specific to violence, as highlighted by a case of forearm amputation (Micarelli et al. 2018b), the bladed injuries experienced by T19 could not be successfully treated. Hence, he died of his injuries.

The osteobiographical approach has proven helpful exploration of the life of this Early Medieval male. It has been done in a way that would not be fully attainable through only palaeopathological study alone. The combination of archaeological, isotopic, and osteological evidence permits the reconstruction of aspects of the social identity of this individual. A narrative of his life history has emerged from multiple life events as indicated by skeletal defects.

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Author contribution CZ, IM and SB conceived and directed the research and wrote preliminary versions of the paper. SB and MAT performed the isotopic analyses. IM performed CT acquisition, and SEM analyses; AP and CZ analysed it. IM and RRP and SDG conducted preliminary analyses. CZ, IM and SB prepared figures and supplementary material. CG supervised the archaeological reconstruction. MAT, RRP and GM reviewed the final version of the paper. All authors contributed equally to the interpretation of results and discussed, revised, and finalised the paper. All authors read and approved the final manuscript.

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Declarations

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