

Testing “Saintly” Authenticity: Investigations on Two Catacomb Saints¹

Amelie Alterauge, MA

Thomas Becker, MSc

Brigitta Berndt, MA

Christian Jackowski, MD

Sandra Lösch, PhD

RadioGraphics 2016; 36:573–579

Published online 10.1148/rg.2016150008

Content Code: **OT**

¹From the Department of Physical Anthropology (A.A., S.L.) and Department of Forensic Medicine and Imaging (C.J.), Institute of Forensic Medicine, University of Bern, Sulgenauweg 40, CH-3007 Bern, Switzerland; Art Conservation, Kuesnacht, Switzerland (T.B.); and Museum Blumenstein, Historical Museum Solothurn, Solothurn, Switzerland (B.B.). Received May 19, 2015; revision requested June 29 and received July 17; accepted July 22. All authors have disclosed no relevant relationships. Address correspondence to S.L. (e-mail: sandra.loesch@irm.unibe.ch).

©RSNA, 2016

Introduction

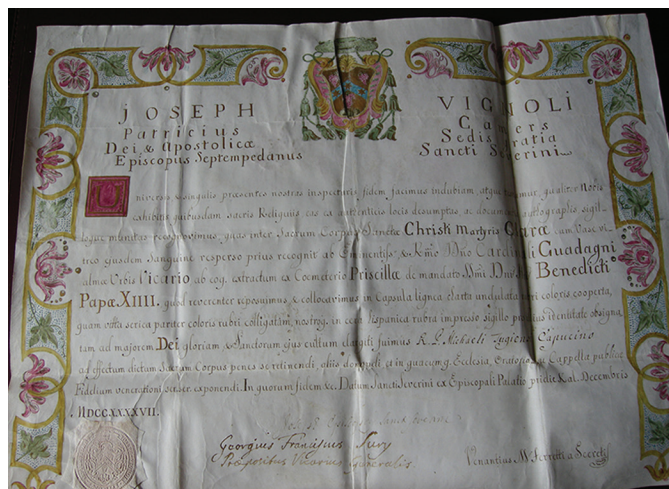
Relic shrines containing human remains have rarely been studied (1–5), usually only when restoration has been necessary. Such investigations were previously restricted to art historical aspects, sometimes including counting and rough identification of bones. The study of relics is still of marginal interest to the life sciences because authorization for research is rarely granted by the church institutions, who fear the exposition of forgeries (6) or damage to the objects (7).

A special category of relics are jeweled skeletons originally deriving from the Roman catacombs. The catacombs of Rome were used as underground burial places for the first Christians in Late Antiquity (the 2nd through 7th centuries). After their rediscovery in 1578, the remains of hundreds of individuals, assumed to be early Christian martyrs, were excavated and sent to Roman Catholic churches and monasteries in German-speaking Europe (8–10). After their arrival in Switzerland, Austria, Hungary, and Southern Germany in the 17th and 18th centuries, these skeletons were newly assembled and lavishly decorated by the nuns of local monasteries before being displayed in a parish church. These so-created *catacomb saints* were intended to replace relics that were lost in the Protestant Reformation.

The goal of this study was to examine two catacomb saints from Switzerland with conventional radiographic imaging and minimally invasive techniques to test their authenticity. In this case, authenticity means that the remains actually originate from the late antique Roman catacombs and were not recovered from local medieval or modern cemeteries for the manufacture of a forgery.

Radiography allows noninvasive and hence nondestructive inspection of elements under soft tissues, textiles, and jewelry and is commonly performed on mummified remains (1,11–15). Mobile projectional radiography was the method of choice to determine the relics' authenticity, as the entire assemblages were too large and fragile for conventional computed tomography and hence required a technique without major displacement of the objects. Radiography is widely used and accepted by art historians, archaeologists, curators, and conservators, as this method enables information about the manufacturing process, compositional changes, and the condition of an object with minimal direct physical contact with the artifact itself (16–18).

Figure 1. Certificate of authentication of Saint Clare. Once extracted from the Priscilla catacombs, the bones were taken to the Apostolic Sacristy for authentication by Joseph Vignoli, the cardinal vicar under Pope Benedict XIV, in December 1747. On the back it is written and sealed that the relics left Rome on October 4, 1752.



This approach superseded the removal of the relics from their shrines and allowed the identification of various manipulations since their recovery from the catacombs. It also permitted the assessment of the state of preservation and manner of assembly of the bones. Furthermore, the individuals' sex and age at death were able to be determined.

Considering the scientific-anthropological approach used, this study is special in research on catacomb saints, although historical and ecclesiastical research on catacomb saints has a long tradition in Switzerland (8,9,19,20). Further importance lies in the critical evaluation of the authenticity of the relics. Important insights into the origin, history, and treatment of these remains are gained. Even if all historical contexts are lost or if human remains have been relocated or reused in later times, relics can still be important sources of information about individuals and later veneration practices.

Catacomb Saints from a Museum Collection

The Historical Museum Blumenstein in Solothurn, Switzerland, houses two catacomb saints, Saint Candidus and Saint Clare, each of them displayed in a baroque shrine lined with draperies and cushions and closed at the front side with glass panes. The reliquaries had been displayed on the side altars of the monastery Name of Jesus in Solothurn for approximately 220 years (21,22). According to the accompanying certificate (Fig 1) issued by the vicar general under Pope Benedict XIV, the bones of Saint Clare were collected in the Priscilla catacombs in Rome in 1747 and arrived at the monastery in January 1753. There is no historical information about the provenance of Saint Candidus' bones.

The skeletons are presented in a typical reclining pose, their skulls turned toward the

viewer. In their hands they hold a palm frond and a sword as signs of their endured martyrdom (Fig 2). They are dressed up in contemporary padded robes like a Roman legionnaire (Saint Candidus) and a baroque angel (Saint Clare) and are entirely covered with monastic handicrafts made of glass, silver, and gold wire. A small reliquary is attached to the backboard of the shrines and contains objects found with the remains in the catacombs.

Investigations of the Saints

Radiographic Imaging

Our radiographic investigation of the shrines took place in May 2013 at the museum. Both relics were scanned with transportable industrial radiographic equipment (Seifert Eresco 42 MF3.1, General Electric Measurement and Control, Billerica, Mass) in anteroposterior projection (inherent filtration, 0.8-mm-thick Be) (Fig 3). A single exposure of each full body was performed, as well as a separate radiograph of the head. As it was not possible to move the remains within the shrines, they were left in their original position and depicted in three-quarter view. The x-ray tube was placed at a distance of 240 cm from the film, which was attached to the shrines' backboard. The depicted objects were approximately 40 cm away from the film. The scanning parameters were as follows: raw data acquisition, 45 kV for Saint Clare and 60 kV for Saint Candidus, 900 mAs, and image processing, Structurix Rollpac D4DW (Agfa, Mortsel, Belgium), Structurix NDT-M (Agfa), 28°C, 1.5-minute immersion. Due to the limited size of a single sheet of x-ray film, the general view of the shrine's content was projected onto three sheets of film, 35 × 240 cm each, placed one above the other to cover the whole area behind the shrines. It was due to the enlarged size of the radiographs that the x-ray films



Figure 2. The catacomb saints Saint Candidus and Saint Clare from the collection of the Historical Museum Blumenstein in Solothurn (Switzerland). **(a)** Detail of the shrine of Saint Candidus. The catacomb saint is presented in a typical reclining pose with the skull turned toward the viewer. He is dressed in padded robes and adorned with monastic handicrafts and beads. Palm frond, laurel wreath, halo, and sword are placed on his body as signs of his martyrdom. The bones are wrapped in gauze. **(b)** Saint Clare in her shrine. The catacomb saint is dressed like a baroque angel holding a sword and a palm frond. A laurel wreath is placed on her head and a halo looms above her.



Figure 3. Placing the portable x-ray tube head in front of the shrine of Saint Candidus.

were photographed with a Cyber-shot camera (Sony, Tokyo, Japan) to digitize the images. These images were not further edited.

Morphologic-Anthropological Investigation

Skeletal representation and features for sex and age estimation were evaluated macroscopically and on the basis of the x-ray images, following common anthropological methods (23–28). Owing to the superimposition of textiles and metallic objects, anatomic areas less frequently studied in physical anthropology had to be used for sex and age estimation. Consistency of examination results between the visual inspection and x-ray assessment was required. Due to the distortion of the images through the x-ray exposure and a resulting magni-

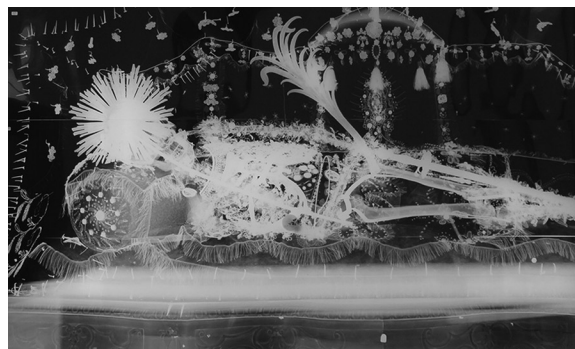
fication of the bones of unknown extent (29), we refrained from estimating body height.

Radiocarbon Dating

Sampling was limited to bone material and to a single sample per individual for conservational reasons. From Saint Candidus, a sample from the right radius was taken, and the right first rib was retrieved from Saint Clare.

Radiocarbon dating was performed at the Department of Geography at the University of Zurich. The samples were chemically pretreated, burned in sealed quartz-glass ampules, and the resulting carbon dioxide gas was converted to graphite. The isotopic content of this graphite was measured using accelerator mass spectrometry at the ETH Laboratory of Ion Beam Physics. The results were

Figure 4. Plain x-ray images of the catacomb saints in their shrines. **(a)** Shrine of Saint Candidus in anteroposterior projection. Easily recognizable are the halo, the palm frond, the corselet, and the sword. The bones are placed in correct anatomic position and held together by a metal rod-and-frame construction. **(b)** Shrine of Saint Clare in anteroposterior projection. The bones are placed in correct anatomic position, assembled together by a metal rod-and-frame construction. The examination of the bones was constrained by the overlap of textiles and jewelry.



a.



b.

calibrated using OxCal version 4.2.3 (Oxford University, Oxford, England) (30,31).

Whose Bones Were Used?

Saint Candidus

Radiography revealed considerable information on the construction and preservation of each catacomb saint. Saint Candidus was represented by bones of a nearly complete skeleton. Some smaller bones (eg, phalanges from hand and foot) were replaced by wooden imitations. A metal frame construction formed the scaffold of the skeleton (Fig 4a). Wires connecting the proximal and distal parts of the bones were attached to this frame. An iron rod attached by a screw thread to the calvaria connected the skull with the thorax. The bones were placed in anatomically correct positions, including their laterality (Fig 4a). The right elbow and the left knee revealed that the joints are not articulated. No supernumerary bones were observed, and all were similar in size and maturation.

Although the visual sex determination was performed on the skull, radiography additionally allowed assessment of the pelvis. The skull features (eg, pronounced mentum, everted gonion, high cheek bones) point toward male sex, and a narrow

subpubic angle of the pelvis observed on the x-ray images indicates the same. Sex determination by the skull and pelvis was therefore consistent and suggests that the individual is male.

Age estimation was on the basis of the maturation of the bones and dental wear. As seen on the x-ray images, all epiphyses were completely fused. The cancellous bone structure of the proximal femoral epiphysis was only marginally degenerated (23). By visual inspection, dental wear was identified to be moderate, as the enamel cusps are still visible (28). The age at death was estimated to be 20 to 40 years of age.

The skeletal elements showed no signs of alteration due to diseases as far as was observable. The second upper-right premolar was lost during the lifetime and was replaced by a false stone tooth for display.

Radiocarbon dating revealed that the sample was from the period 259–415 AD (2- σ significance, calibrated).

Saint Clare

Construction and preservation details were obtained by visual examination and radiographic imaging. Saint Clare was represented by skeletal elements from the upper and lower extremities, the pectoral and pelvic girdle, the thoracic

cage, and the head (Fig 4b). Except for some ribs and smaller hand and foot bones, the bones represented an almost complete individual. The scaffold of the skeleton was identical to that of Saint Candidus. The position of the bones followed the human anatomy and laterality. No supernumerary skeletal elements were present in the remains, and all resembled each other in size and maturation.

As the pelvis was covered by opaque jewelry, sex determination was performed only on the skull. The chin and orbital outline are rounded. In addition, the bones of Saint Clare are more gracile than those of Saint Candidus. Those characteristics suggest that the individual is probably female. The complete fusion of all epiphyses was observed on the x-ray images. Therefore, the bones are full-grown. All third molars were present. Only the lambdoid suture could be evaluated: In the radiography, it appears to be not yet ossified. All these indicators suggest an adult age of between 20 and 40 years at death. No signs of pathologic alterations on the long bones were observed. The dentition showed severe caries in the upper-right first premolar and molar. Only tooth stumps remain from these teeth.

According to the radiocarbon dating, the sampled bone dated to 128–315 AD (2- σ significance, calibrated).

Saintly Authenticity Reviewed

Visual inspection and radiography joined their forces in the appraisal of the construction and preservation of the catacomb saints. Considering their recovery, transportation, and manipulation, the bones of both relics were in remarkably good condition. Compared with other catacomb saints (2,3), both individuals consisted of nearly complete skeletons. The bones were consolidated and protected from moisture by several layers of gauze glued on the bone surface. The abundant use of wires wound around the proximal and distal parts of the bones, which were later covered by textiles, proves that the greatest emphasis was put on the outer appearance rather than on skilled craftsmanship. However, the joints were aligned in such a way that they replicated actual human postures. The ability to present a complete corpus gave the relics impressive character that is unprecedented. The effect was intensified by the presentation in a lavishly decorated shrine lined with velvet draperies and cushions. Radiography confirmed that the monastic handicrafts attached to the shrine's draperies and saints' clothes were made from different materials, as deduced from their opacity. Glass gems, gold and silver filigree wires, sequins, and embroideries

can be distinguished. Further information on materials and manufacture has to be gained through visual inspection. For example, the accompanying items (eg, swords, corselet) predate the relics' assemblage in the 18th century and were reused for the purpose of the remains' embellishment.

A surprising result of the radiography, albeit one that has been observed in other cases as well, was the placement of the bones in anatomically correct position (further examples in Koudounaris [3]), although the joints are now disarticulated. This implies a certain anatomic expertise of the nuns who assembled the remains. It remains unclear if they sought help from physicians and/or books.

A major limitation of the study was that the in situ contexts of the remains were no longer preserved. It is possible that the bones originally belonged to several individuals and were only pooled together for display. Radiography permitted exclusion of this possibility: As no supernumerary bones could be observed in either of the individuals and the bones resembled each other in size, maturation, and color, the skeletal elements for each of the saints probably derived from single individuals. Consistent sex determination on the skull and pelvis of Saint Candidus further supports this assumption. However, some smaller bones went missing during extraction or transport and were later replaced by wooden imitations. To conclude, the skeletons were most likely packed into boxes right after removal from their graves, presumably in the catacombs, and then transported to Switzerland, so that comingling was unlikely to have occurred. Only systematic sampling for ancient DNA analysis and comparison of all bones of each individual could dispel any remaining doubt. This applies to the sex determination, as well, which was limited in this study to morphologic evaluation.

Evaluating features on radiographic images is challenging, as the latter are superimposed two-dimensional representations of a three-dimensional object, and as such they are limited in providing exact depths and locations of the internal structures. We attempted to orient the radiation source, the shrines, and the x-ray films in a way that reduced distortion of the images. The x-ray radiation was mainly absorbed by the metal construction elements or decorations that largely superimposed skeletal features. To overcome the difficulties of age and sex estimation, a combination of both visual and radiographic assessment was performed. Radiography increased the number of evaluable features, even though the lack of knowledge of the population's morphologic characteristics and age-related degeneration processes hampered the estimations.

Tracing the historic identity of the individuals was even more challenging. Although the attribution of skeletal remains to a certain historical person of religious importance is always questionable, this is particularly true for remains from the Roman catacombs. As Johnson (10) pointed out, it was a *de facto* assumption in the 17th and 18th centuries that every bone found in the catacombs belonged to a martyr. Due to their late antique dating and Christian beliefs proved by inscriptions, paintings, or grave goods, the skeletons from the catacombs were thought to be those of martyrs. Venerating them as saints was a fictitious creation of the Roman Catholic Church as an attempt to replace the relics that were destroyed during the Protestant Reformation. Given the exploding number of new saints whose remains were venerated in German-speaking Europe, it is obvious that most of them must have been simple Christians without major religious importance. However, it must be noted that the radiocarbon date for the catacomb saint Candidus roughly matches the data available for the historical Candidus, who died in AD 287 as commander of the Theban Legion. But as his mortal remains are thought to have been recovered in Saint-Maurice, canton of Valais, Switzerland, where his calvaria is still on display in a bust reliquary (32), it is very unlikely that the catacomb saint could be identified as the historical Saint Candidus. Historical authenticity is even more unlikely for the remains of the presumed Saint Clare. The historical Clare of Assisi lived in Italy during the 13th century and founded the Order of Poor Ladies, to which the monastery “Name of Jesus” in Solothurn belongs. Due to their dating, the investigated remains cannot be those of Clare of Assisi. The monastery in Solothurn probably received relics bearing the name of their patron to pay tribute to her and to increase the local appeal of the new catacomb saint (3).

Saintly authenticity can be excluded insofar as the investigated bones do not belong to the historic canonized saints Clare and Candidus. However, radiocarbon dating proved at least the late antique dating of parts of the skeletons. Due to the certificate that should have attested their saintly authenticity, a Roman origin of the relics can be assumed. The late antique period coincides with the time when the Roman catacombs were used by early Christians for burial. Given the vast dimension of the catacombs and their continued use between the 2nd and 5th centuries AD (33,34), it is not surprising that the two individuals differ slightly in dating.

Conclusion

This study highlights the merits of scientific investigations of bone material from reliquaries

to test their authenticity and to uncover information about the people behind them. It brought new insights into the origin of a specific group of Roman Catholic relics, the so-called catacomb saints. The radiographic investigation revealed that detailed anatomic knowledge and skilled craftsmanship were applied in assembling the bones to whole-body relics. It further enabled sex and age determination. By radiocarbon dating, the late antique origin of the bones was confirmed.

To sum up, testing the saintly authenticity of the relics of Saint Candidus and Saint Clare revealed that even though the individuals cannot be the historical canonized saints, the catacomb saints are possibly authentic when referred to their origin, integrity, sex, and dating. The investigation verified the authenticity of the relics as historic artworks.

References

1. Dedouit F, Guglielmi G, Perilli G, et al. Virtual anthropological study of the skeletal remains of San Fortunato (Italy, third century AD) with multislice computed tomography. *J Forensic Radiol Imaging* 2014;2(1):9–16.
2. Prader N. Reliquiengebeine. Nur Überreste eines Toten? Dekomposition, Schadensursachen und Konsolidierung am Beispiel des Katakombenheiligen Placide [Relic mortal remains. Only dead remains? Decomposition, causes of damage and consolidation of the catacomb saint Placide] [master's thesis]. Bern, Switzerland: Hochschule der Künste Bern [Bern University of the Arts], 2012.
3. Koudounaris P. Heavenly bodies: cult treasures and spectacular saints from the catacombs. Trento, Italy: Thames & Hudson, 2013.
4. van Strydonck M, Eryvynck A, Vandenbruaene M, Boudain M. Anthropology and 14C analysis of skeletal remains from relic shrines: an unexpected source of information for medieval archaeology. *Radiocarbon* 2009;51(2):569–577.
5. Fulcheri E. Mummies of saints: a particular category of Italian mummies. In: Spindler K, Wilfing H, Rastbichler-Zissernig E, zur Nedden D, Nothdurfter H, eds. *Human mummies: a global survey of their status and the techniques of conservation*. Vienna, Austria: Springer, 1996; 219–230.
6. Charlier P, Poupon J, Eb A, et al. The “relics of Joan of Arc”: a forensic multidisciplinary analysis. *Forensic Sci Int* 2010;194(1–3):e9–e15.
7. Pulz W, Büttel S, Helebrant T. Unverwundlichkeit als körperliches Zeichen der Heiligkeit: Die Mumien von Vodnjan/Dignano [Incorruptibility as physical sign of sainthood: the mummies of Vodjan/Dignano]. In: Sörries R, ed. *Geschichte und Tradition der Mumifizierung in Europa: Beiträge zu einer Tagung im Museum für Sepulkralkultur 2010* [History and tradition of mummification in Europe: proceedings of a conference in the Museum for Sepulchral Culture 2010]. Kassel, Germany: Arbeitsgemeinschaft Friedhof und Denkmal, 2011; 103–111.
8. Achermann H. Die Katakombenheiligen und ihre Translationen in der schweizerischen Quart des Bistums Konstanz. [Catacomb saints and their translation in the Swiss part of the diocese of Constance]. Stans, Switzerland: Historischer Verein Nidwalden [Historical society of Nidwalden], 1979.
9. Stükelberg EA. Geschichte der Reliquien in der Schweiz. [History of relics in Switzerland]. Zürich, Switzerland: Verlag der Schweizerischen Gesellschaft für Volkskunde, 1902.
10. Johnson T. Holy fabrications: the catacomb saints and the Counter-Reformation in Bavaria. *J Ecclesiast Hist* 1996; 47(2):274–297.
11. Jackowski C, Bolliger S, Thali MJ. Common and unexpected findings in mummies from ancient Egypt and South

- America as revealed by CT. *RadioGraphics* 2008;28(5):1477–1492.
12. Panzer S, Zink AR, Piombino-Mascoli D. Scenes from the past: radiologic evidence of anthropogenic mummification in the Capuchin Catacombs of Palermo, Sicily. *RadioGraphics* 2010;30(4):1123–1132.
 13. Rühli FJ, Chhem RK, Böni T. Diagnostic paleoradiology of mummified tissue: interpretation and pitfalls. *Can Assoc Radiol J* 2004;55(4):218–227.
 14. Fulcheri E. Saints and illnesses in faith and paleopathological evidences [in Italian]. *Med Secoli* 2006;18(3):815–830.
 15. Wade AD, Garvin GJ, Hurnanen JH, et al. Scenes from the past: multidetector CT of Egyptian mummies of the Redpath Museum. *RadioGraphics* 2012;32(4):1235–1250.
 16. Becker T. The art of x-raying art and cultural assets [in German]. *Schweisstechnik* 2013;102(1):17–20.
 17. Lang J, Middleton A. *Radiography of cultural material*. Oxford, England: Elsevier Butterworth-Heinemann, 2005.
 18. Schreiner M, Frühmann B, Jembrih-Simbürger D, Linke R. X-rays in art and archaeology: an overview. *Powder Diffraction* 2004;19(01):3–11.
 19. Schnyder W. Relics and accompanying artifacts of catacomb saints in Switzerland: historical and archaeological aspects to their assessment [in German]. *Zeitschrift für schweizerische Kirchengeschichte* 1931;25:134–149.
 20. Henggeler RP. Die Katakombenheiligen der Schweiz in ihren bildlichen Darstellungen [in German]. *Zeitschrift für schweizerische Archäologie und Kunstgeschichte* 1939;1(3):156–175.
 21. Weber E. Klosterleben: 400 Jahre Alltagsleben im Frauenkloster “Namen Jesu” [Convent life: 400 years of everyday life in the nunnery “Name of Jesus”]. *Jahresbericht 2009 Museum Blumenstein, Historisches Museum Solothurn* [Annual report 2009, the Museum Blumenstein, Historical Museum Solothurn]. http://www.museumblumenstein.ch/files/blumenstein_jahresbericht_2009.pdf. Published 2010. Accessed July 17, 2015.
 22. Werner SV, Kully RM, Rindlisbacher H, Röder A. Chronicle of the Capuchin nunnery Name of Jesus in Solothurn 1609–1913 [in German]. *Jahrbuch für Solothurnische Geschichte* 2009;82:15–172.
 23. Acsádi G, Nemeskéri J. *History of human lifespan and mortality*. Budapest, Hungary: Akadémiai Kiadó, 1970.
 24. Ferembach D, Schwidetzky I, Stloukal M. Recommendations for age and sex diagnoses of skeletons [in French]. *Bull Mem Soc Anthropol Paris* 1979;6(1):7–45.
 25. Herrmann B, Grupe G, Hummel S, Piepenbrink H, Schutkowski H. *Prähistorische Anthropologie: Leitfaden der Feld- und Labormethoden*. [Prehistoric anthropology: guide of field and laboratory methods]. Berlin, Germany: Springer Verlag, 1990.
 26. Sjøvold T. Geschlechtsdiagnose am Skelett. In: Knussmann R, ed. *Anthropologie: Handbuch der vergleichenden Biologie des Menschen*. [Anthropology: handbook of comparative human biology]. Stuttgart, Germany: Gustav Fischer Verlag, 1988; 444–480.
 27. Szilvássy J. Altersdiagnose am Skelett. In: Knussmann R, ed. *Anthropologie: Handbuch der vergleichenden Biologie des Menschen*. [Anthropology: handbook of comparative human biology]. Stuttgart, Germany: Gustav Fischer Verlag, 1988; 421–435.
 28. Miles AEW. Dentition in the assessment of individual age in skeletal material. In: Brothwell DR, ed. *Dental anthropology*. London, England: Pergamon, 1963; 191–209.
 29. Carlton R, Adler A. *Principles of radiographic imaging: an art and a science*. Boston, Mass: Cengage Learning, 2012.
 30. Reimer PJ, Bard E, Bayliss A, et al. IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP. *Radiocarbon* 2013;55(4):1869–1887.
 31. Bronk Ramsey C, Lee S. Recent and planned developments of the program OxCal. *Radiocarbon* 2013;55(2-3): 720–730.
 32. Schnyder R. The head reliquary of saint Candidus in St-Maurice [in German]. *Zeitschrift für Schweizerische Archäologie und Kunstgeschichte* 1965–1966;24(2):65–127.
 33. Toynbee JMC. *Death and burial in the Roman world*. Baltimore, Md: Cornell University Press, 1971.
 34. Pergola P. *Le catacombe romane: storia e topografia*. [The Roman catacombs: history and topography]. Rome, Italy: Carocci, 2002.