

# Preservation of single human hearts from archaeological and historical contexts

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**Abstract.** The work analyzes a series of cardiac remains from archaeological and historical contexts, from different periods and from different parts of the world. They have undergone an often natural conservative process, facilitated by certain environmental conditions, sometimes artificial, with the precise desire to give individual importance to the heart. The analysis of these hearts is mainly aimed at the presence or absence of pathological aspects present in each of them and focuses attention on the scientific and medical importance that can also be found in organic remains from contexts of this type.

**Key words:** anatomy; cardiology; paleopathology; anthropology

## Introduction

In religious and ritual contexts, the heart has always represented the most important organ of the individual (1).

In different historical periods and in very different cultures we always find the same will to give the heart its own individuality and its own importance, distinct and equal to the body (1-3).

These hearts are the result of profoundly different preservation processes (4), carried out in a natural or totally artificial way.

In general, natural mummification consists of the rapid dehydration of an organism after its death.

Some environmental parameters, can facilitate the mummification and the conservation of the remains over time (5). These parameters are absolutely variable and depend on a series of collateral factors. Tissue dehydration can be due to very hot and dry weather (e.g. sandy deserts); to the presence of hygroscopic salts in the soil (e.g. phosphorus, copper and iron salts); to acidic environments (e.g. the peat bogs); to the presence of natural disinfectants (mercury) or fumes (6-7).

In other cases, it is directly the human's hands

to carry out the conservative methodologies (8). The practice of embalming is generally linked to funeral rites that preceded the burial. The artificial dehydration of the corpse was obtained through the use of various techniques typical of the different cultures. The artificial mummification process could involve the removal of the viscera which, in ancient Egypt, were kept in special vessels, the use of hygroscopic mineral salts, and the use of ointments and resins and bandages to cover the body (6-7).

Sometimes the two dynamics coexist, and it is decided to stop the incomplete putrefactive process at a certain moment.

The historical periods of the cardiac remains cover a fairly wide range: from ancient Egypt to modern period. In each historical moments profound importance has been given to ritual burials, to the commemoration of eminent religious or secular figures, to life after death (1, 2, 4). The purposes and methodologies used to preserve the hearts may have been different, but the common goal; in many cases the heart, seat of the soul, after death requires specific veneration and must be preserved separately from the body and other organs.

In Ancient Egypt, for instance, embalming prac-

tices involved the removal of internal organs and their conservation in canopic jars accompanying the deceased. The heart, instead, was left inside the chest as a pass for the afterlife. In the late period the organs were then individually mummified but reinserted into the body (9). This is how, therefore, the discovery of an Egyptian-era heart outside the deceased is a rather rare event.

In the Middle Ages and the Renaissance, instead, the attestations of single hearts extracted from the body are more frequent. The hearts were deliberately exposed as a relic to be venerated, often kept inside a reliquary that highlights its importance (3).

In Europe, the practice of preserving the heart dates back to the twelfth century and then continued into modern times, with a peak in the seventeenth century (2). Borgo (10) reports that approximately seven hundred hearts were extracted from the body during this period. Furthermore, the author describes some cases of isolated conservation of hearts that belonged to important historical figures, including the Polish national hero Tadeusz Kosciuszko (1746-1817), and the musician Fryderyk Chopin (1810-1849). Bradford lists various hearts remains of characters, who covered an important political, social and religious role: e.g. the hearts of William the Conqueror (1027-1087), Philip IV the Fair (1268-1314) and Charles V, kings of France (for the complete list of cases, the reader is invited to consult the Bradford and Borgo publications of (2, 10).

The goal of the work is to report other cases of ancient hearts to be added to those already listed in the literature (2, 10). The importance of these human remains lies in the fact that they can provide valuable information on the life of characters from the past, data that cannot be deduced from historical, literary and archaeological sources. Sometimes the ancient hearts show pathological signs, that are of medical-scientific interest.

## Materials and methods

All the hearts lacking of the proper historical contextualization and information were left out from the work.

The search for new cases in the literature and on the web was carried out using the keywords “mummified hearts” and “relics hearts” on bibliographic search engines Scopus, Web of Science, Pubmed, Google Scholar. The authors also analysed the bibliography of scientific articles in order to identify additional cases not identified by search engines and published in national journals and books with limited distribution.

## Results

The bibliographic research allowed us to identify n. 15 cases of hearts extracted from the body and kept separately in reliquaries (Table 1). All the cases that emerged from the research come from historical European contexts; as far as we know, the only exception is represented by an embalmed heart that belonged to a Vizier of the Pharaoh Amenemhat I, that was the first king of the XII Dynasty of the Middle Kingdom (11).

## Discussion

Historical studies and anthropological analyses of human remains in some cases highlighted the conservation of ancient hearts or their parts, which have been preserved over the centuries (Table 1).

The first case comes from Ancient Egypt. In 2017 an archaeological mission in discovered the tomb of Ipi, Vizier under the pharaoh Amenemhat I, in the area between el-Asasif and Deir el-Bahari, West Thebes (11).

His heart was found inside the accompanying canopic jars. As already mentioned, it was a ritual for the heart to be reinserted into the thoracic cavity, so this case is almost unique. In fact, it is very rare to find a heart from this period that is not, even if treated separately, inside the body of the deceased or totally absent. The reasons for the heart extraction can be various, from human error to burial dynamics. The heart in question was mummified carefully and separately from the body, wrapped in bandages, before being placed in the vase (11).

The next case is that of the heart of Saint Alfio. He was arrested and executed, together with his two

brothers, for treason against the imperial power, in 253 A.D. In 1500 the relics were found and the heart of Saint Alfio, the most important, which survived the Saracen raid, has since then been kept in a reliquary and exposed for the veneration (12). The relic is carried every year in procession to Lentini (Italy), the city where he died and which still venerates him today.

Another case of notable relevance is that of the heart of King Richard I of England, called Richard the

Lionheart. The indomitable courage and audacity that marked each of his undertakings as a man and warrior earned the King this title, which he wanted to honor even on his deathbed. During the Middle Ages the post-mortem dismemberment of the corpses of famous people (13), destined for different burials and/or purposes, was not uncommon. The heart, in particular, was the most important organ, representing the soul of the deceased since ancient times. King Richard, be-

**Table 1.** Historical Cases of ancient single hearts.

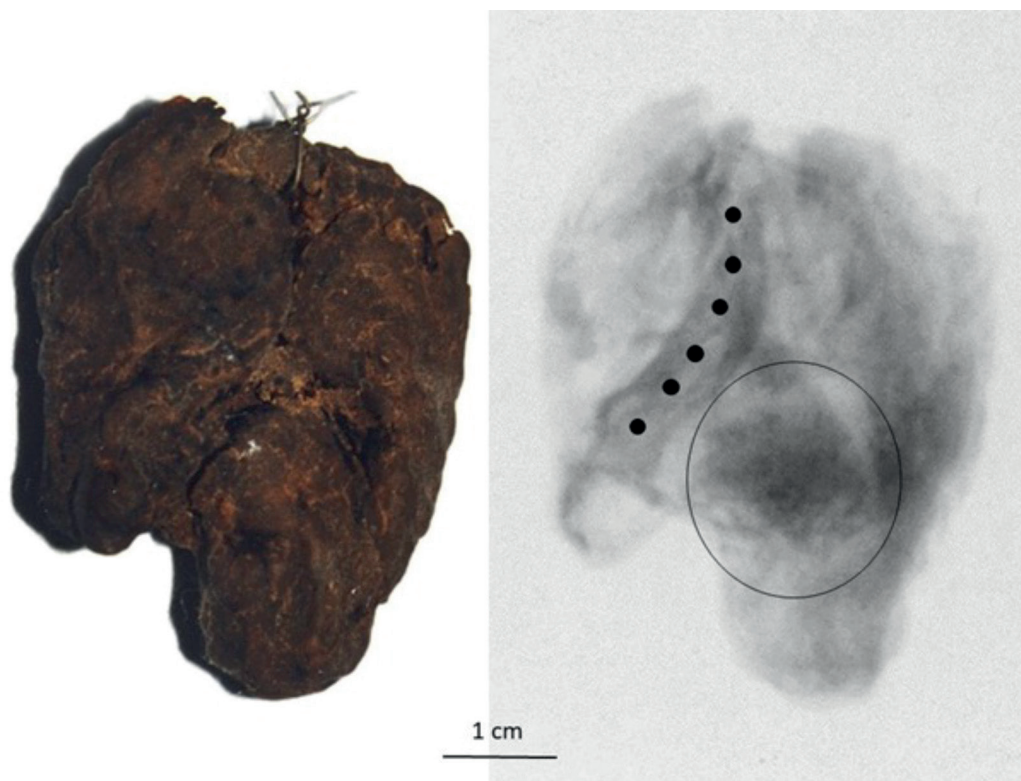
Historical figure	Sex	Age of Death	Historical Period	Place of Conservation	Intact	Pathological	References
Vizier Ipi	M	-	1994-1964 b. C.	Deir el-Bahari (Egypt)	x	-	Carillo M et al. 2018
Saint Alfio	M	-	253 A.D.	Lentini (Italy)	x	-	Dei F, 2021
King Richard the Lionheart	M	42	1157-1199 A.D.	Rouen (France)	-	-	Charlier P et al., 2013
Saint Rose of Viterbo	F	18	1233-1251 A.D.	Viterbo (Italy)	x	x	Capasso L et al., 1999; D'Anastasio R et al., 2010
Saint Clare of Montefalco	F	40	1268- 1308 A.D.	Montefalco (Italy)	x	-	Papalini M et al., 2021 Park K, 2002
Saint Teresa of Avila	F	67	1515-1582 A.D.	Alba de Tormes (Spain)	x	x	Biro Barton M, 1982; Bueno-Gómez N, 2019
Saint Carlo Borromeo	M	46	1538-1584 A.D.	Rome (Italy)	x	-	Navoni M, 2011
Saint Camillo de Lellis	M	64	1550-1614 A.D.	Rome (Italy)		-	camilliani.org
Saint Vincent De Paoli	M	79	1581-1660 A.D.	Paris (Italy)		-	Miquel P, 1996
Saint Francesco di Sales	M	55	1567-1622 A.D.	Treviso (Italy)	x	-	Wirth M, 2021
Blessed Anne-Madeleine Remuzat	F	33	1696-1730 A.D.	Marseille (France)	x	x	Charlier P, et al., 2014
Louis XVII	M	10	1785-1795 A.D.	Paris (France)	x	-	Jehaes E et al., 2001
Admiral Andreas "Miaoulis" Vokos	M	66	1769-1835 A.D.	Hydra (Greece)	x	-	Stefanou E, 2012
Admiral Kostantinos Kanaristhe	M	87	1790-1877 A.D.	Athens (Greece)	x	-	Stefanou E, 2012
Blessed Pauline Marie Jaricot	F	62	1799-1862 A.D.	Lion (France)	x	-	Bourdin V et al., 2023

b. C.: before Christ; A.D.: Anno Domini; F: Female; M: Male

fore dying on April 6, 1199, ordered to bury his body near his father's tomb, in the Abbey of Fontevault, his entrails in Châlus and his heart in Rouen (Normandy, France), his gift to the city whose inhabitants had demonstrated an incomparable loyalty (13). During some excavations in the cathedral of Notre Dame of Rouen, in July 1838, the historian Achille Deville found, next to the funerary effigy of Richard I, an intact lead box containing the remains of the heart of the King. The sealed box (12.2 x 23 x 17 cm) was engraved with a funerary inscription: *Hic iacet cor ricardi regis anglorum*, i.e. "Here is the heart of Richard, King of England". The heart was subjected to numerous biomedical analyses, which ascertained the practice of embalming. Invasive analyses (such as, genetic analysis and carbon dating) were not performed, due to the fragility of the relic. The heart had been treated using substances inspired by Biblical texts and necessary for the long-term preservation of the organ. The organ was deposited in linen, associated with myrtle, daisy, mint, frankincense, creosote, mercury and lime. This type of embalming associates the deceased with

Christ, whose body was covered with perfumed ointments upon death. The study demonstrates how even King Richard's heart was treated and covered with a mixture of plant and mineral material. It is not known whether the treatment took place entirely as the organ was found almost completely pulverized. Furthermore, there is no evidence of embalming relating to this period (end of the 12th century a. C.) (13).

The heart of Saint Rose of Viterbo (Italy, 1233-1251) was extracted posthumously after her death, in 1924, from the naturally mummified body (14). The specimen consists of the mummified ventricles lacking the atria and the great arteries and systemic and pulmonary veins. The left ventricle has a diverticulum, which gives the apex of the heart a bifid appearance. The X-ray analysis revealed a right deviation of the ventricular septum and the presence of a mass, probably a thrombus, between the apex of the left ventricle and the entry of the diverticulum (Fig.1) (15). Contrary to what was hypothesized on the basis of some historical information, which attributed the cause of death to tuberculosis, the Saint probably died due to



**Figure 1.** The heart of Saint Rose: macroscopic and radiographic aspects. Black dots show the deviated ventricular septum; the circumference includes the thrombus.

a cardiac embolism caused by the thrombus. The hypothesis seems confirmed by the fact that the biomolecular and paleopathological analyzes of the mummy showed no evidence of an infectious chronic disease occurred in vitam. Moreover, the ventricular diverticulum is one of the most common heart defects described in patients with Cantrell's syndrome and is frequently associated with development of thrombus and subsequent embolisation.

Capasso and colleagues (14) hypothesize that Saint Rose was affected by Cantrell syndrome, which is generally characterized by the presence of ventricular diverticula and frequently associated with development of thrombus and subsequent embolisation.

The heart is now kept separately from the rest of the body, in a reliquary with a controlled atmosphere characterized by low relative humidity and low partial pressure of oxygen; these parameters prevent the reactivation of putrefactive processes.

The heart of Saint Clare of Montefalco (Italy, 1268- 1308) is displayed in a silver reliquary bust, in a niche next to the body of the Saint. Among the various episodes that characterized her life, the Christian tradition recalls the meeting that Saint Clare had with Christ carrying His Cross in the cloister garden in 1294. She wished to take the Cross from Him, and the signs of the Passion entered her heart. Clare bore pain in her heart for many years and when her co-sisters dissected her body the evening of her death, they found the imprint of a cross in her heart (16-17).

The Heart of Saint Teresa of Avila (1515-1582) is also preserved in a glass case, in Alba de Tormes (Spain). Santa Teresa is well known for her many mystical experiences (18-19). In one of the most famous mystical experiences described in her autobiography, Saint Teresa of Avila states that her heart was pierced by an arrow of God's love (18) (pp. 581-598) : "*I saw in his hand [of an angle] a long spear of gold, and at the iron's point there seemed to be a little fire. He appeared to me to be thrusting it at times into my heart and to pierce my very entrails; when he drew it out, he seemed to draw them out also, and to leave me all on fire with a great love of God. The pain was so great, that it made me moan; and yet so surpassing was the sweetness of this excessive pain, that I could not wish to be rid of it.*". Some believers say they can still see the puncture of the spear in her heart.

In the Basilica of SS. Ambrogio and Carlo al Corso, in Rome, the heart of Saint Carlo Borromeo is kept in a golden reliquary. Cardinal Carlo Borromeo (1538-1584) was archbishop of Milan from 1564 until his death in 1584 (20). The reliquary of his heart was donated in 1616 by Cardinal Federico Borromeo. As far as we know, there are no known episodes from the life of Saint Carlo linked to his heart.

About the heart of Saint Camillo de Lellis (1550-1614), Fr. Sazio Ciatelli, a contemporary of St. Camillus, provides an accurate description of its extraction from the body during the autopsy immediately after death (21). The relic is now kept in Rome, in the cubiculum of the Church of the Maddalena, the place where the Saint died.

A particle of the heart of St. Vincent De Paoli (1581-1660), together with other relics of the Saint, is kept today in Turin, at the Provincial House of Missionaries. The whole heart, after having passed from hand to hand immediately after being extracted from the body, re-turned to France after the revolution in 1805 (22). St. Francis de Sales (1567-1622) rests in Annecy, France, but his heart is kept in Treviso, Italy. Here, in fact, there is a monastery of the visitadines, an order founded by the Saint, who brought their hearts from Lyon to Italy (23).

The heart of Blessed Anne-Madeleine Remuzat (1696-1730) was thought to be a case of "miraculous" conservation and, because of it, preserved in a wooden reliquary within the basilica of Sacred Heart in Marseille (France). Analysis by Charlier et al. (24) show that the heart was artificially mummified, with the cavities filled with honey, odoriferous plants and mineral substances (mainly lime and copper). Moreover, the heart show a dilatation of the right ventricle diagnosed as a post-tuberculosis condition, which could be the cause of her death (24).

Another interesting case is undoubtedly that of the heart of Louis XVII (1785-1795), secretly removed from the child immediately after his death and passed from hand to hand for centuries. Genetic analysis established with certainty that remains belong to the Dauphin of France and demonstrated the incorrectness of public rumors, which claimed that Louis XVII would be secretly set free thus avoiding death (25). The hearth of Louis XVII is now deposited in the

crypt of the basilica of Saint-Denis (France), together with other two important hearts of French history: Louis XIII (1601-1643) and Louis XIV, the Sun King (1638-1715). These two had a troubled history: in 1793, during the French revolution, hearts of princes and princesses were destroyed. However many of them were stolen and sold for the realisation of "Mummy Brown", a very rich brown bituminous pigment used by the Pre-Raphaelite painters. The last buyer was Alexander Pau de Saint Martin, who used only part of the Sun King's heart, and returned it with the intact heart of Louis XIII in 1815. Nowadays, the two hearts are preserved within a chest adorned with silver and bronze angels holding a silver heart. The practice of using human remains to make pigments has led to the destruction of numerous relics, such as the heart of queens Anne and Marie-Thérèse of Austria, Monsieur, Philippe d'Orléans and Madame Henriette (all acquired by the French painter Martin Dröller (26).

Two other cases come from contemporary Greece. The hearts of two national heroes from the Greek War of Independence (1821-1830) were mummified and kept into urns as "national heirlooms". Admiral Andreas "Miaoulis" Vokos (1769-1835) was the patriot, who successfully commanded the greek revolution naval forces against the Turks. He is buried in Piraeus near the tomb of Themestocel, the founder of the ancient Athenia Navy, and his heart rests in an urn, first exhibited at the Ministry of Commercial Navy, now in the Historical Archive-Museum of Hydra (27). Admiral Kostantinos Kanaristhe (1790-1877) began his career under the orders of Miaoulis, then he became an admiral during the Greek war of independence and finally he was several times Minister of the Navy and Prime Minister. He is buried in the First Cemetery of Athens, while his heart is kept in a silver urn at the National Historical Museum of Athens. Their hearts were embalmed and kept separately as a religious-like symbol for the preservation of the national memory in general and maritime identity in particular (27).

The last case analysed is that of the heart of Blessed Pauline Marie Jaricot (1799-1862). The French nun spent her entire life helping the needy and French missionaries abroad, founding an association, the Society for the Propagation of the Faith, which undertook to raise money precisely to enable missionaries to trav-

el. She was beatified on May 22, 2022 in Lyon, the same city where she died on January 9, 1862. In the last two months of her life, the Blessed was very ill: she had been coughing up blood and a wound had formed in her chest (28). At her death, the heart was extracted and was kept first in the Archdiocese of Lyon and then in the Church of Saint-Polycarpe (Lyon), where it rested since 1888. The complete scientific examination of Pauline Jaricot's heart was commissioned to the research team on the occasion of the Beatification process; the researchers established that the heart did not undergo any post-mortem embalming procedure and was therefore preserved in a completely natural way. It was also ascertained that the cause of death, despite the physical conditions of Pauline Jaricot, is not to be attributed to a heart problem. The heart appears, in fact, almost completely intact, with dark spots attributable to post-mortem blood loss (the heart was placed in the reliquary still fresh). The morphology of the organ is perfectly in line with that of a non-pathological human heart (28).

## Conclusions

This brief report aims to describe a series of cardiac findings from historical and archaeological contexts, which are stored separately from the body.

The historical periods to which these hearts belong vary from the Egyptian period to the contemporary era.

The biographies of the historical figures to whom the hearts belonged, are rich in episodes taken from historical and iconographic sources. However, the anatomical and pathological analyses of their ancient hearts could add new insights into their lives. The case of Saint Rose of Viterbo (14-15) is emblematic in this sense and suggests that the other cardiac remains could also provide interesting data from a medical, scientific and historical point of view.

The cases published in the literature refer to historical figures who had an important religious, political or social role. Research findings suggest that heart preservation is a widespread practice especially in Europe, whose populations have identified in the heart a symbol of community and/or national identity. In the

end, the cases examined in the study, especially those that have not yet shown pathological signs, can provide a starting point for future work and scientific study.

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