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# *Hydrocephaly at the Medici Court of Florence (16th century)*

10th Jubilee Multidisciplinary International
Conference of Neuroscience and Biological Psychiatry
**"Stress and Behavior"**
St-Petersburg, Russia
May 16-20, 2007

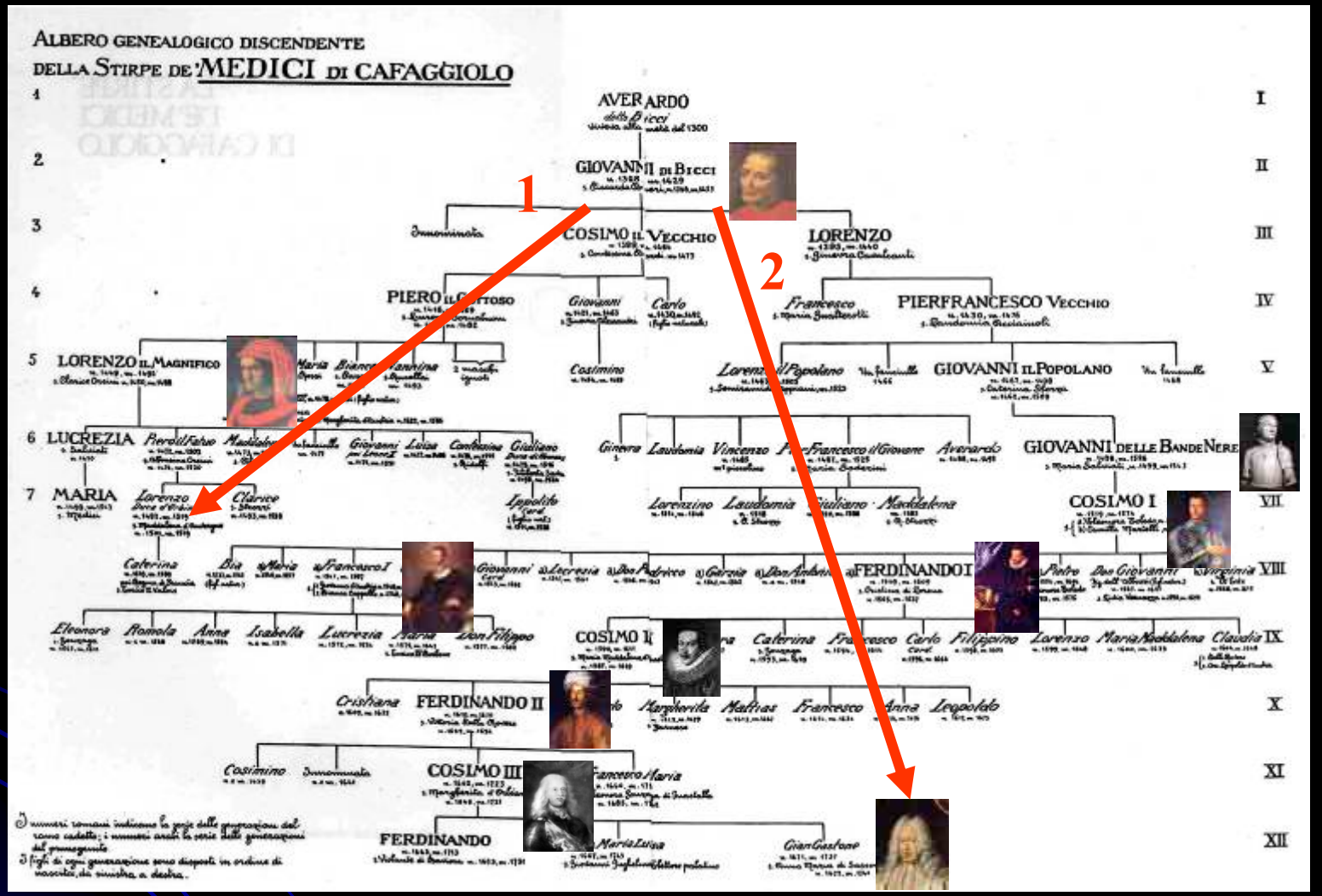
The Medici were one of the most powerful families of the Italian Renaissance. Starting from the 14th century, their careful management of banking ventures and skilful political actions brought them to the forefront of social and political power in Tuscany and in Florence, the intellectual centre of the Western world.

Lorenzo the Magnificent
(1446-1492)
Vasari, Uffizi Gallery

Michelangelo
Tomb of Giuliano de' Medici
(Medici Chapels, Florence)

Lovers of art and science, the Medici were patrons of Michelangelo, Leonardo da Vinci, Botticelli, Galileo, and Benvenuto Cellini.

# THE MEDICI FAMILY TREE




There are two main branches in the Medici family tree: the branch of Lorenzo the Magnificent (1446-1492) and the branch of the Grand Dukes of Tuscany, which began with John of the Black Bands (1498-1526) and ended with Gian Gastone (1671-1737), the last Grand Duke. The most important members of this impressive dynasty were buried under the vaults of the Basilica of San Lorenzo in Florence.

# THE "RICH" PATHOLOGY OF THE MEDICI FAMILY
(from archive documents)

INFECTIOUS AND PARASITIC DISEASES

METABOLIC DISEASES

JOINT DISEASES

CARDIOVASCULAR DISEASES

POISONINGS

TUMORS

MALFORMATIONS

smallpox
tuberculosis
malaria
syphilis
obesity
anemia
urinary stones
familial arthritis
arteriosclerosis
chronic intoxications
breast cancer
dwarfism


Ferdinando II (1610-1670)


Eleonora from Toledo (1522-1562)


Francesco Maria (1660-1710)


Maria Salviati (1499-1543)


Ferdinando (1663-1713)


Cosimo III (1642-1723)


Cosimo I (1519-1574)


Francesco I (1541-1587)


Anna Maria Luisa (1667-1743)


Maria Cristiana (1609-1632)

# THE “MEDICI PROJECT”

John of the Black Bands
(1498-1526)

Cosimo I
(1519-1574)

In 2003, dr. Antonio Paolucci, Superintendent of Florentine Museums, granted permission to examine 49 of the Medici burials in the Basilica. The "Medici Project" focuses on the Grand Dukes, who are less known than Lorenzo and his descendants.

The project involves collaboration among the University of Pisa, the University of Florence, and the Superintendence of Florentine Museums.

The research programme includes funerary archeology, physical anthropology, paleonutrition, parasitology, pathology, histology, histochemistry, immuno-histochemistry, electron microscopy, molecular biology, and identification of ancient pathogens.

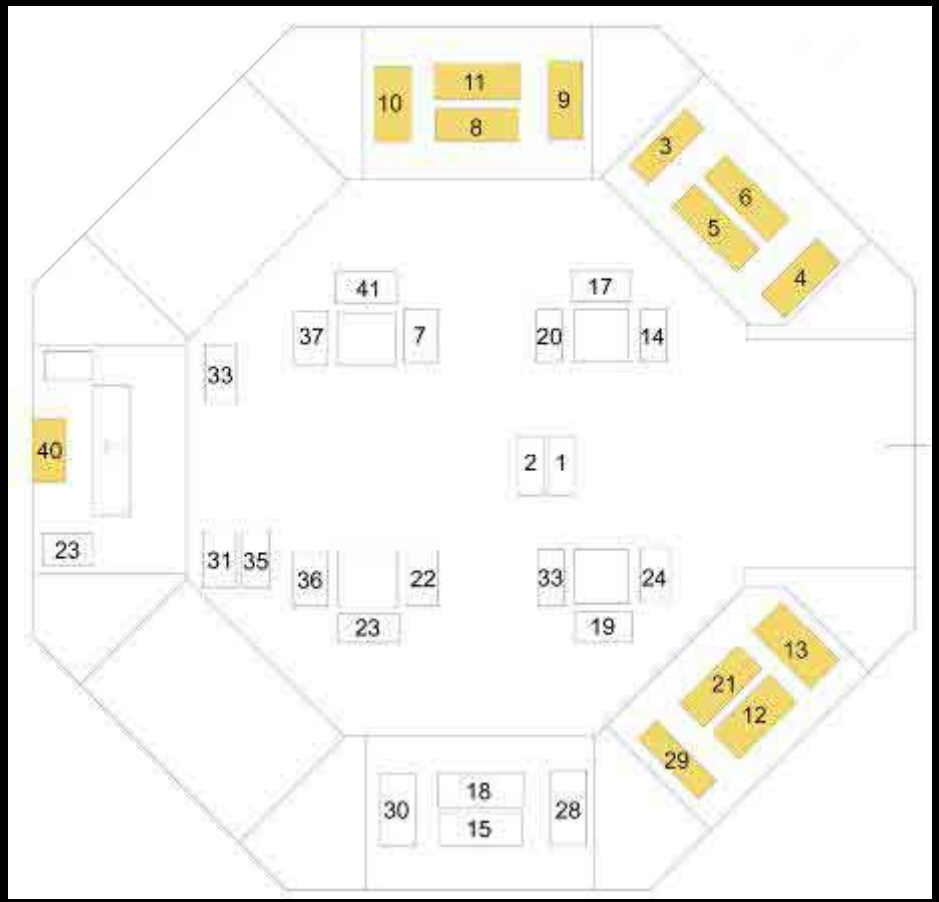
The most recent biomedical techniques have been employed in order to obtain as much information as possible about the life style, health and environment of these famous rulers of Renaissance Florence.

Eleonora from Toledo
(1522-1562)

Anna Maria Luisa
(1667-1743)

# THE CRYPT OF SAN LORENZO

The crypt of the Basilica of San Lorenzo in Florence, Mausoleum of the Grand Dukes of the Medici family.




Map of the crypt, with the Medici tombs already explored in yellow.

Richter (1737), Florence, Palatina Gallery

We decided to begin our examination with the intact tomb of Gian Gastone (1671-1737), the last Grand Duke of the Medici.

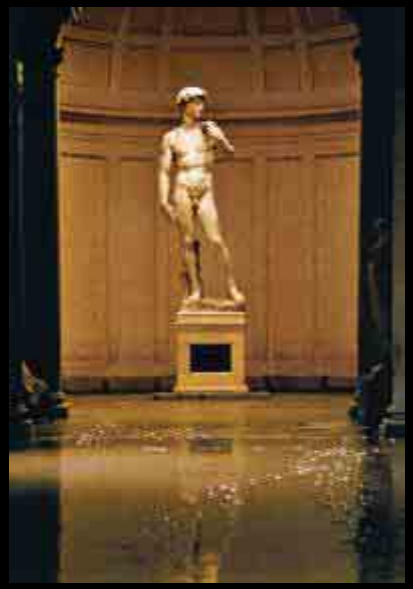

This is the slab of marble with his epigraph…

…and this is the position of a plain dark marble disk with no epigraph, considered a simple floor decoration.

The removal of the marble disk in the floor of the chapel displayed a secret opening with a small stone stair leading to a hidden crypt.

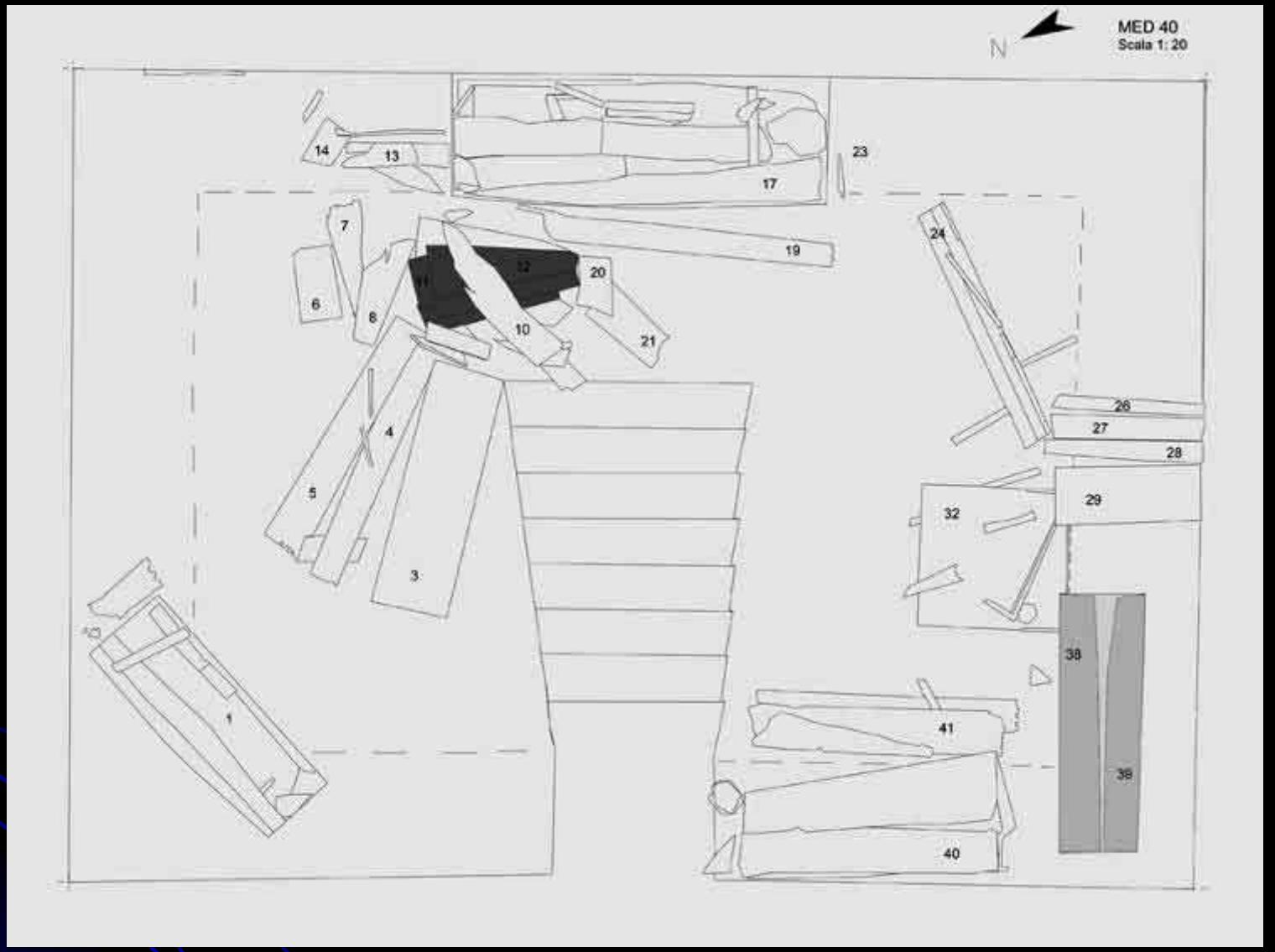

The hidden crypt at the moment of discovery.

(by NATIONAL GEOGRAPHIC)



An image of the Florence flood of 1966
(by NATIONAL GEOGRAPHIC)

A low raised platform running around the base of the crypt's walls supported a large sarcophagus and many small wooden coffins; these coffins had completely collapsed on the floor, covered by a layer of dry mould from the disastrous flood of 1966.




The archeological relief, with the exact position of the great sarcophagus of Gian Gastone opposite the stairs and many small coffins collapsed on the floor or variously distributed on the plane.

The lid of the sarcophagus of the Grand Duke Gian Gastone, badly damaged, had collapsed into the interior, revealing the inner coffin of lead with a large Christian cross.

The body of the Grand Duke was intact: he was covered by the silk Great Cape *(Cappa Magna)* of the Grand Master of Knights of the Order of St Stephen and was still wearing his funerary crown.

Other small coffins of children, collapsed on the floor or variously distributed on the raised floor level, were visible in the crypt.

Contrary to all expectations, several of the burials in the small wooden coffins were fairly intact. The elaborate costume of a 5-year-old child, complete with shoes and silver crown, showed an excellent state of preservation.

The red silk jacket with a thin collar and buttons was adorned with silver gallons and large plus-fours in the same flowery fabric.

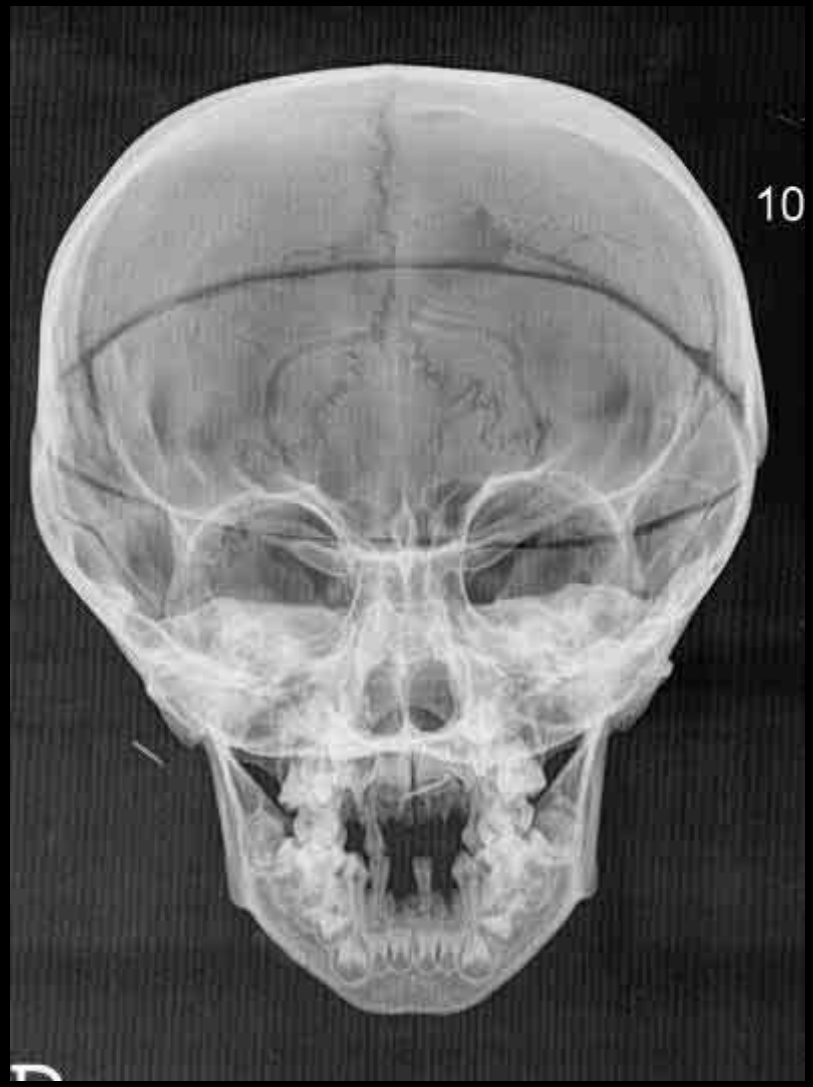
The anthropological study of this individual, nicknamed “the child with the red jacket”, revealed a little boy of about 5 years, with a stature of ca 1.15 m.

The child was identified as don Filippino (1577-1582), son of the Grand Duke Francesco I, who died at the age of 5 in 1582.

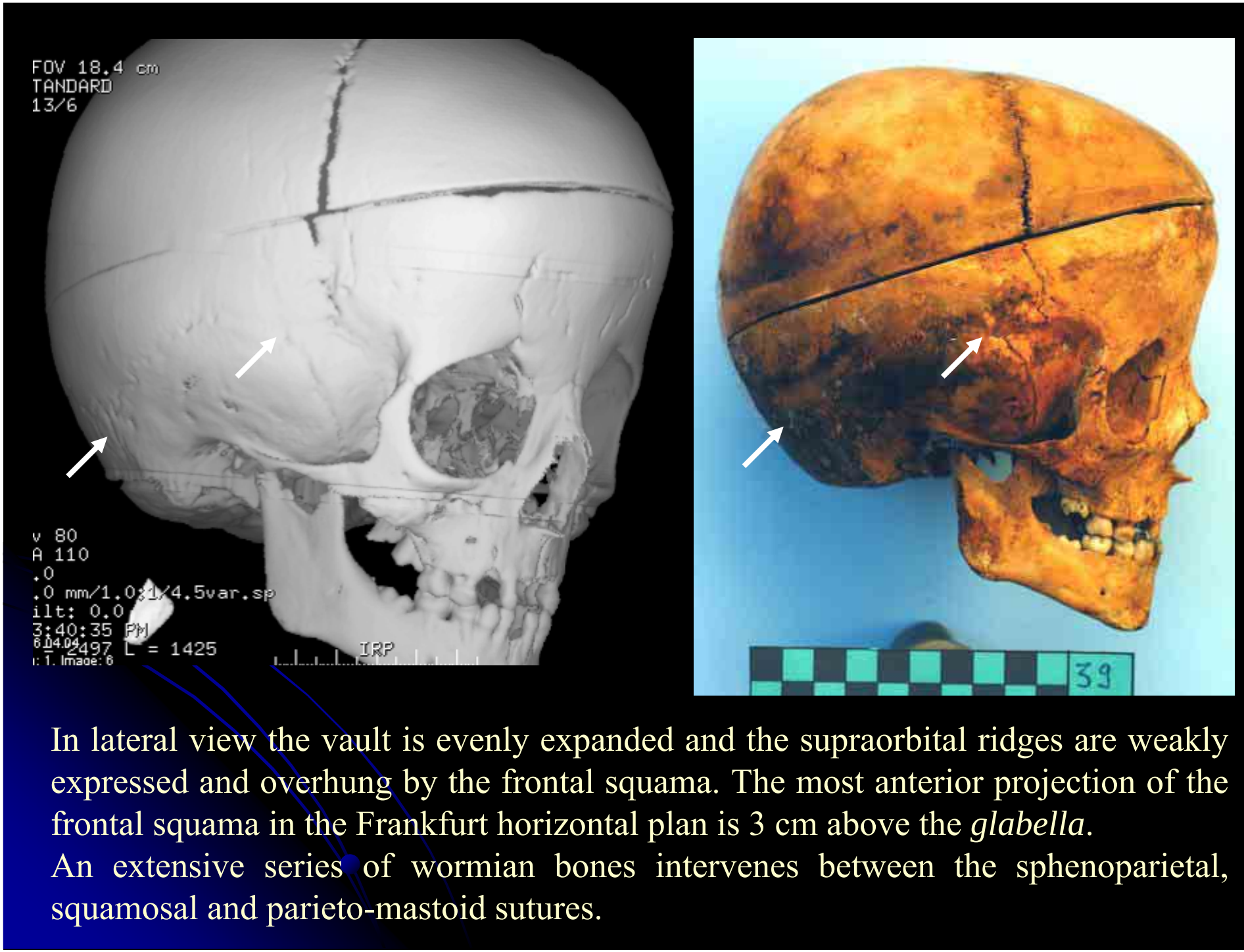
Bizzelli (1586), *Giovanna from Austria and her son Filippo*, Florence, Uffizi Gallery

Alessandro Allori (1581?)
Madrid, Prado Museum

The costume too is very similar to that worn by Don Filippino, portrayed with his mother, the Grand Duchess Joan from Austria.

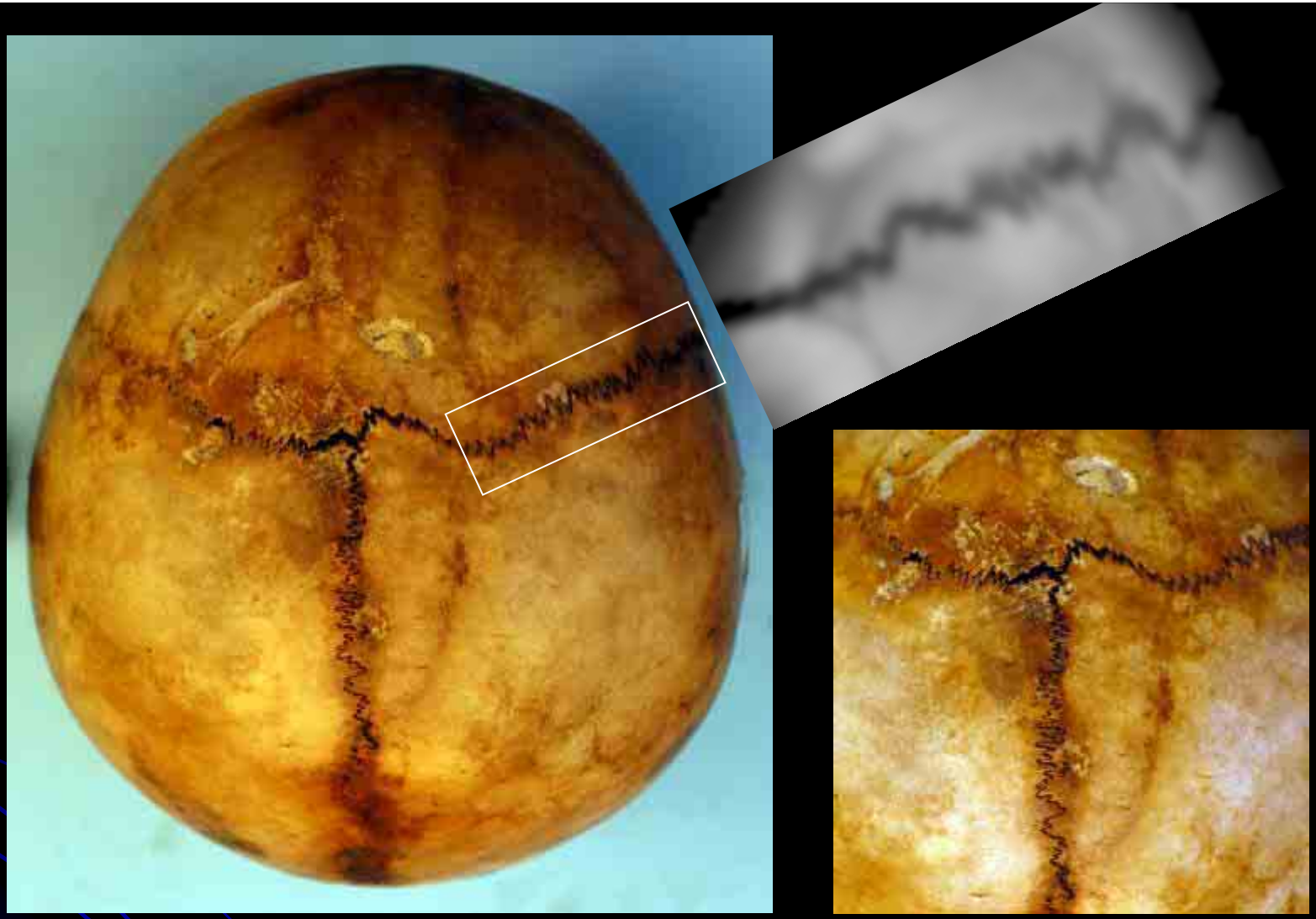



The skull of the child reveals some important peculiarities.
In anterior view we can see the vault expands evenly. The facial skeleton has a normal conformation, with the exception of a relatively high mandibular symphysis.




In lateral view the vault is evenly expanded and the supraorbital ridges are weakly expressed and overhung by the frontal squama. The most anterior projection of the frontal squama in the Frankfurt horizontal plan is 3 cm above the *glabella*.

An extensive series of wormian bones intervenes between the sphenoparietal, squamosal and parieto-mastoid sutures.



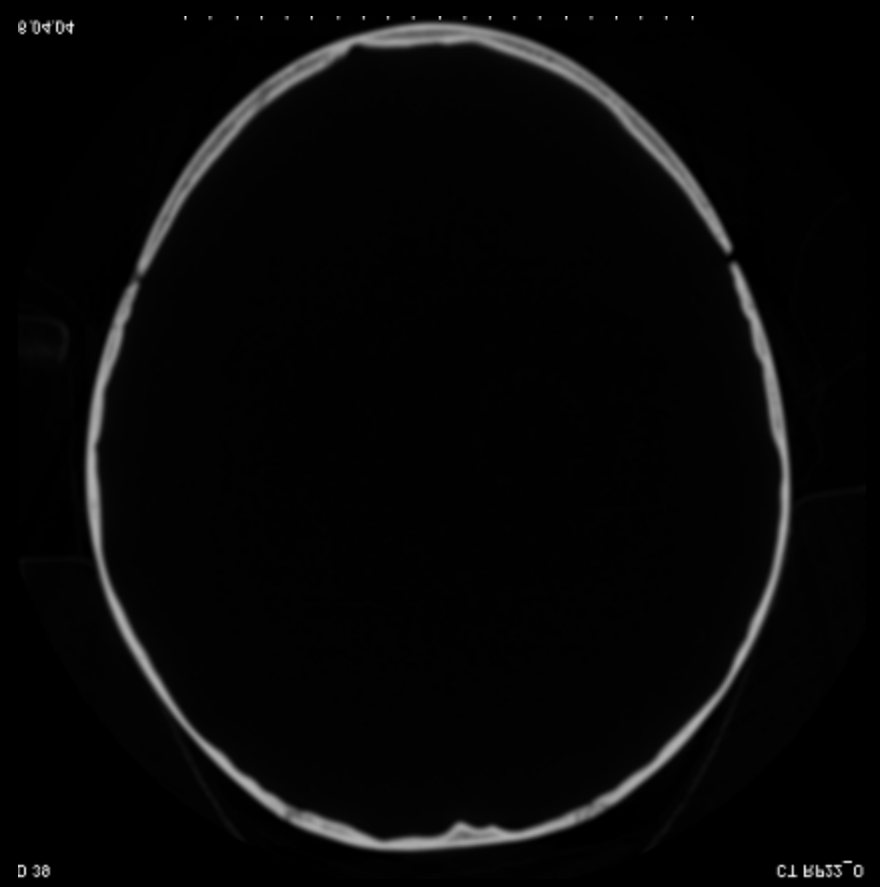
In superior view the cranial outline is ovoid.
The vault is narrow anteriorly and maximally expanded at the parietal eminences. Coronal suture formation is relatively complete, but very diastased, in particular in the *bregma* region. While it is normal for a 3 year old child to have open cranial sutures, their presence (more than 2 mm) at the age of 5 years is indicative of a development anomaly.

In posterior view the vault is rounded. The left side is slightly flatter than the right.

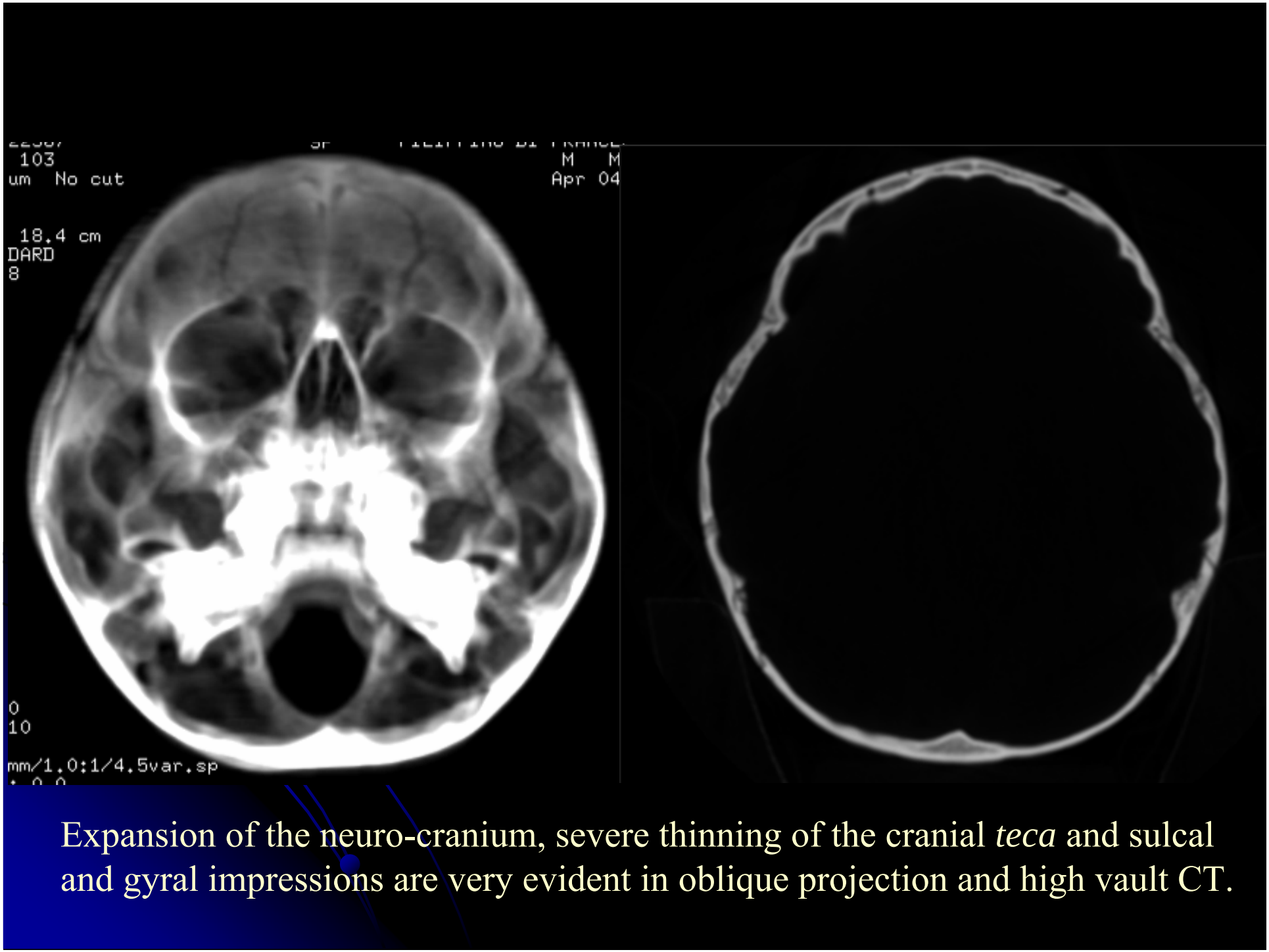
The vault tapers from the parietal eminences to the level of the mastoid processes.

Attachment sites for the *falx cerebri* and *cerebelli* and the *tentorium cerebelli* are exaggerated and sharp.

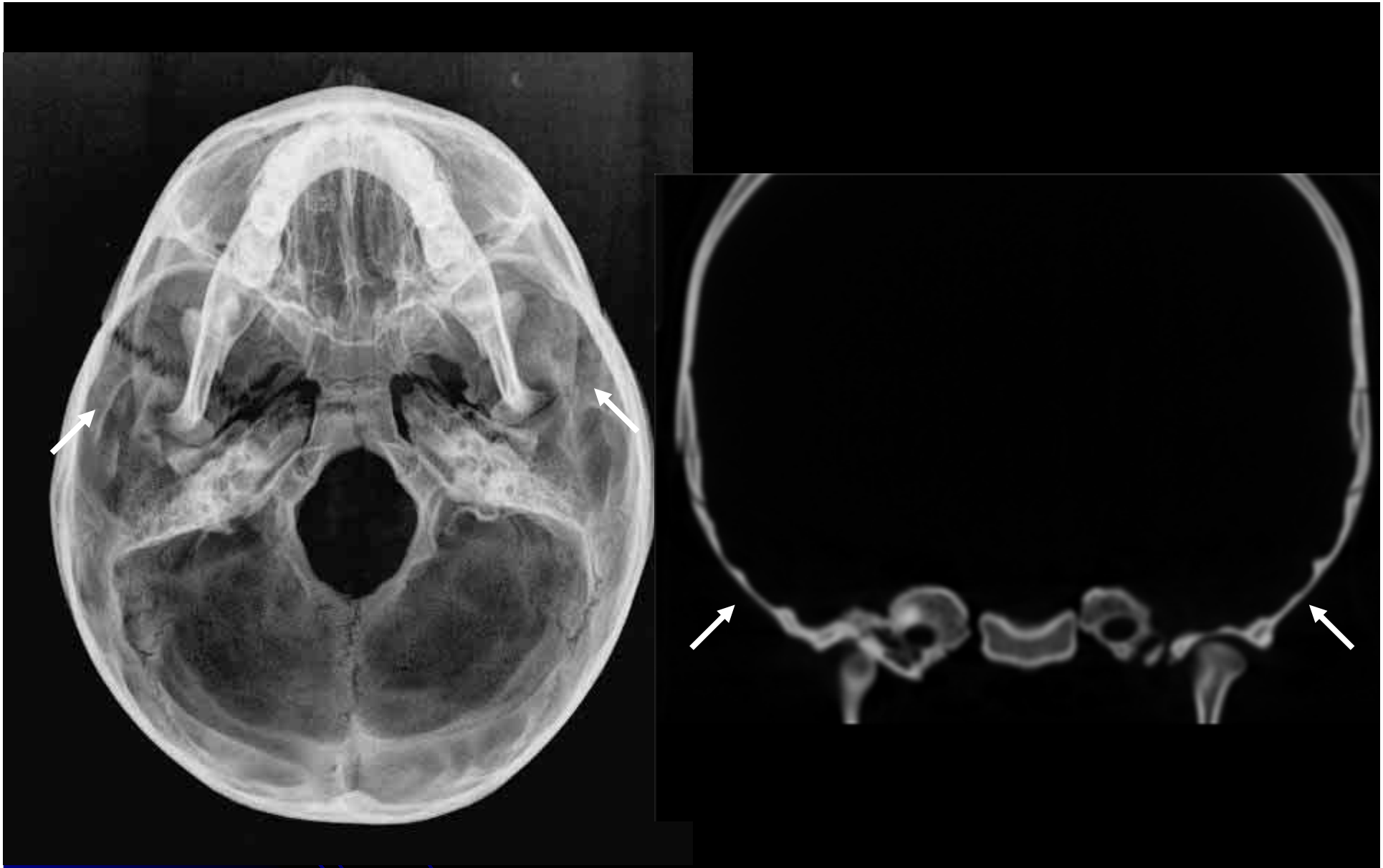
The superior petrous crest and borders of the transverse sulci (*tentorium cerebelli*) of the occipital are extended.

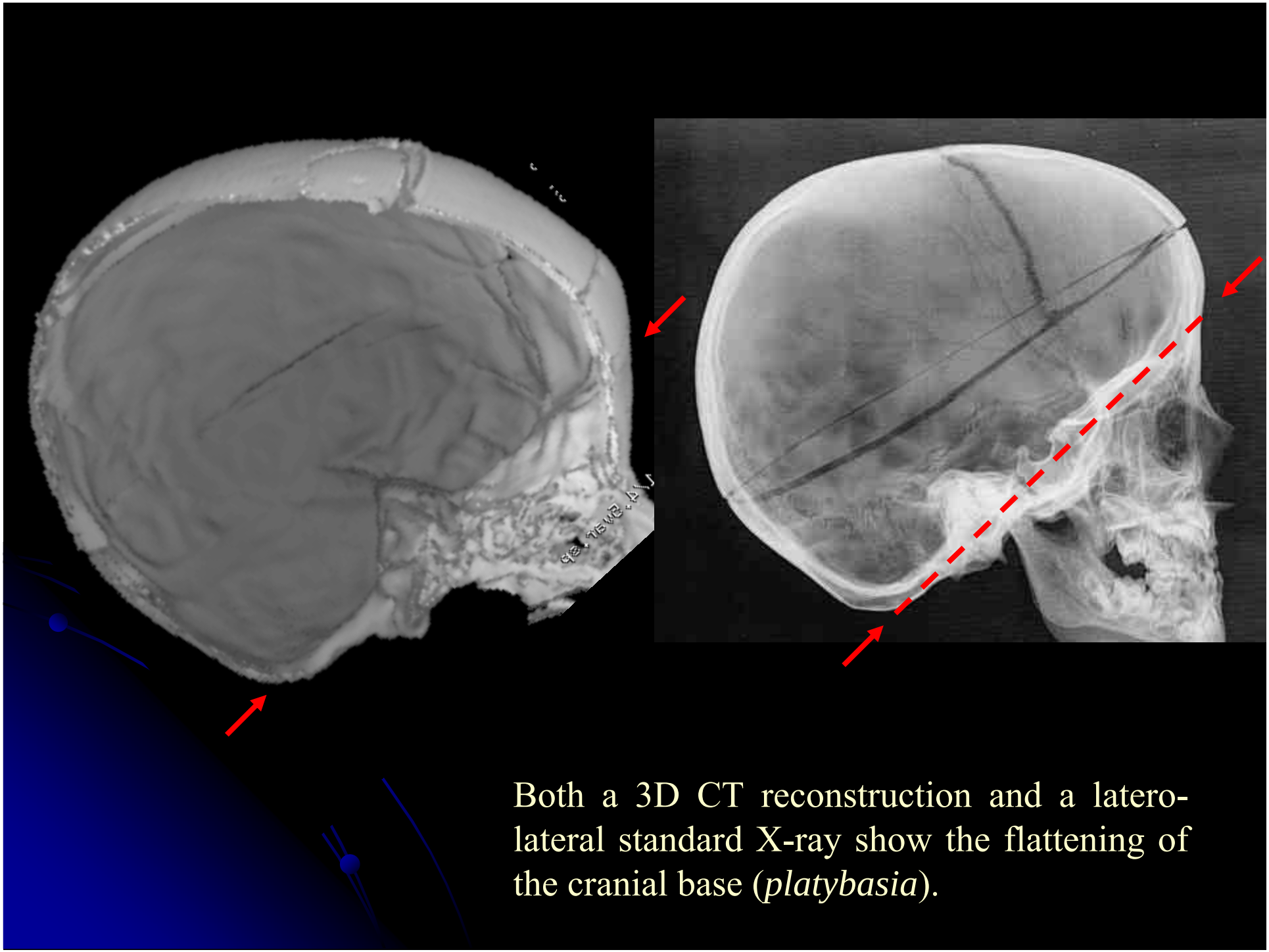
The endocranial surface is unusually heavily marked by sulcal and gyral impressions, particularly in the region of the parietal and occipital lobes. Grooves of the branches of the middle meningeal vessels and nerves are abnormally deep and expanded. The cranial *teca* is very thin and translucent.




Expansion of the neuro-cranium, severe thinning of the cranial *teca* and sulcal and gyral impressions are very evident in oblique projection and high vault CT.



The thinning of the teca and marked gyral impressions are also well visible, at standard X-ray and CT, in the anterior cranial *fossa*.



Both a 3D CT reconstruction and a latero-lateral standard X-ray show the flattening of the cranial base (*platybasia*).

We found increased cranial sizes, ranging from 1 to 4 SD above average (maximum cranial breadth, maximum frontal breadth, maximum circumference, frontal arc, frontal chord, cranial capacity) and reduced or normal facial dimensions (nasal breadth, orbital breadth, palatal breadth, bigonial breadth and symphysial height).

| Skull measurements | don Filippino | Comparative sample | |
|---|---|---|---|
| | | M | SD |
| 1. Maximum cranial length | 157 | 159.6 (21) | 6.1 |
| 8. Maximum cranial breadth | **140↑↑** | 128.0 (21) | 5.4 |
| 9. Minimum frontal breadth | 84.2 | 83.5 (21) | 3.9 |
| 10. Maximum frontal breadth | **120↑↑↑** | 104.4 (26) | 5.6 |
| 12. Biasterionic breadth | 100 | 98.1 (22) | 3.6 |
| 23. Maximum circumference | **465↑** | 451.3 (15) | 11.5 |
| 26. Frontal arc | **134↑↑↑↑** | 116.0 (24) | 4.5 |
| 29. Frontal chord | **107↑↑** | 99.3 (24) | 3.7 |
| 27. Parietal arc | 110 | 114.9 (23) | 6.1 |
| 30. Parietal chord | 99 | 103.1 (23) | 4.9 |
| 28. Occipital arc | 115 | 110.2 (22) | 6.3 |
| 31. Occipital chord | 97 | 91.9 (22) | 4.6 |
| 51. Orbital breadth | 31 | 32.3 (23) | 1.3 |
| 54. Nasal breadth | 17 | 18.8 (20) | 1.0 |
| 66. Bigonial breadth | 72 | 71.3 (21) | 2.7 |
| 69. Symphysial height | 23.5 | 23.6 (30) | 1.6 |
| 38. Cranial capacity | **1553 cc** | 1400 cc | |

↑: >1 Standard deviation (SD); M: sample means

Allori copy (1582?)
Florence, Poggio Imperiale Villa

A portrait of don Filippino, painted in the same year of death (1582), shows a head with low implant of the orbits and auricles and evident expansion of the cranial vault, compatible with a non-severe hydrocephaly.

These features:

- enlargement of the head
- thinning of the skull bones
- widely separated sutures with wormian bones
- atrophy of the supraorbital ridges
- flattening of the cranial base

are considered sufficient for a diagnosis of hydrocephaly.



The post-cranial skeleton shows evident rickets, with curvature of the left *tibia* and *fibula*.

## “Clinical history” of don Filippino

Don Filippino was the seventh son, and only male, of the Grand Duke Francis I and Joan from Austria; he was born on May 20 1577 and «*was immediately baptized at night because, owing to his troublesome birth, there was fear for the newborn’s life*». Indeed, his delivery was long and difficult, as a result of his mother’s pelvis dystocia.

Baroccio, Florence, Palatina Gallery

Philip grew up frail and sickly, with frequent indispositions and slight persistent fevers. Psychic development must have been normal, because at 5 years of age he was already able to sign his letters.

These are the archive data about the child prince's diseases.

| Age | Date | Disease |
|---|---|---|
| 1 year | May 7, 1578 | bronchitis with fever |
| 2 years | December 9, 1580 | "severe weakness" |
| 2 years | 1580 | "attacks of nerves", "convulsions" |
| 5 years | March 13, 1582 | "tertian" (intermittent) fever, epilepsy, "convulsions", coma |
| | March 29, 1582 | death and autopsy |

At autopsy, the surgeon opened the skull of the child with a very precise, horizontal cut. He used a bone saw and obtained an accurate horizontal craniotomy.

The archival documents contain the autopsy report of don Filippino, which provides an accurate description of a typical hydrocephalus:

"*On 29th March Filippo, great Prince of Florence, died… he was buried in* (the church of) *san Lorenzo. The doctors who had cured him – both physicians and surgeons – cut his head and removed the cranial vault as if it were a bowl and found, underneath the first membrane of the brain,* (the equivalent of) *almost a glass of water, so that they all thought that this had been the real cause of his death*"

Lapini, Florentine Diary, 1589

…"(The doctors) *opened the (body of the) Prince and found his head full of water*"

Letter of the Grand Duke Francis I to his brother, the Cardinal Ferdinand (7th April 1589)

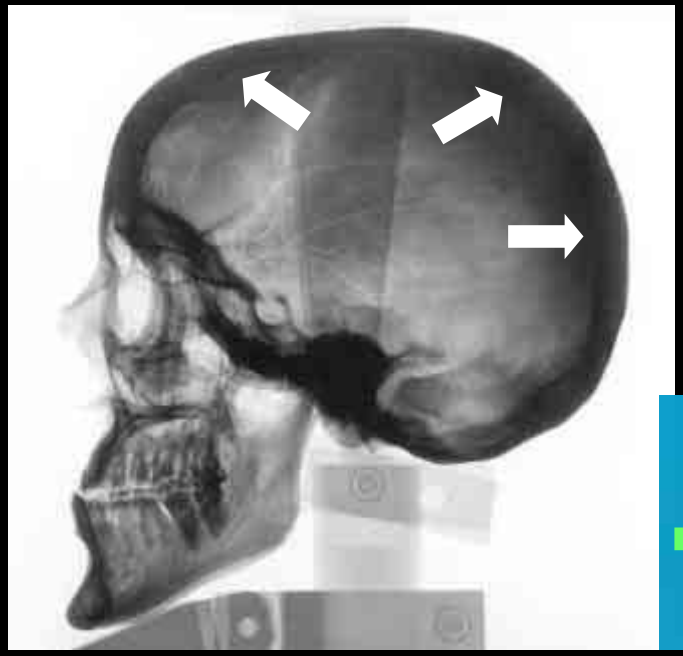
## “Clinical history” of Joan from Austria, mother of don Filippino

Joan appears in numerous portraits; she was not very attractive and some contemporary reports even describe her as "hunchbacked".
She survived six very difficult deliveries, but died at the age of 30 during childbirth after the rupture of the uterus.

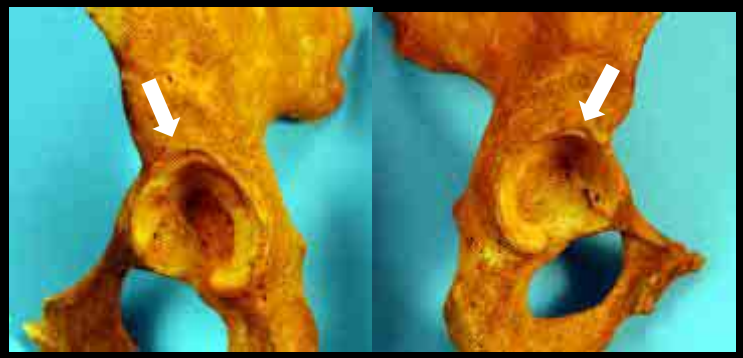
The skeleton of Joan from Austria reveals a woman with a skeletal age of 25-35 years and stature of 1.58 m. The weak muscular insertions suggest very limited physical activity.

The paleopathological study of the skeleton shows a veritable collection of disorders:

- mandible prognatism – the famous Habsburg jaw! – (red arrow)
- marked congenital hyperostosis (ca 1 cm) of the cranial vault (white arrows)
- *amelogenesis imperfecta* of the dental crowns (green arrows)

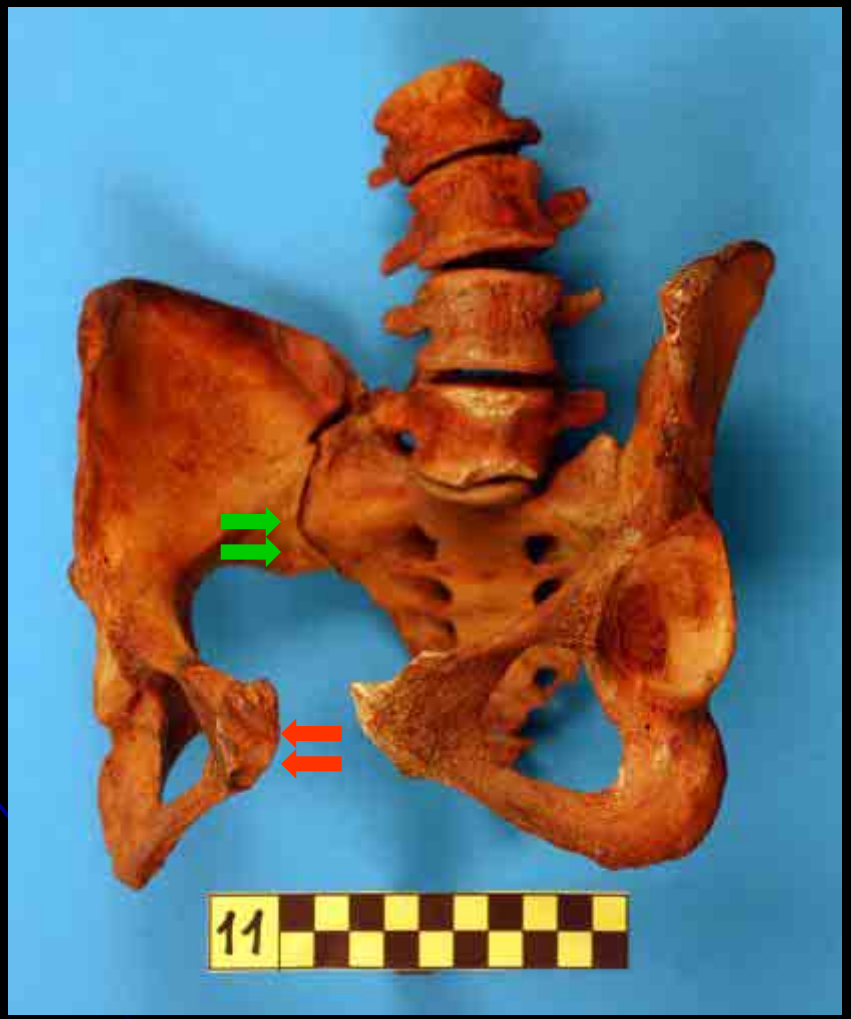


- incomplete congenital dislocation of the hip (white arrows)



- severe scoliosis of the lumbar column with impressive deformity of the pelvis (which well explains her difficult deliveries and death for rupture of uterus)

The enormous retro-pubic *foveae* in her pubic symphysis (red arrows) and the deep pre-auricular *sulci* (green arrows) bear witness to her numerous difficult deliveries.



# CONCLUSIONS

This is a case of non-severe external hydrocephaly, as witnessed by the macroscopic and radiological study, and by the 16th century autopsy report which describes an increase of water underneath "the first membrane" (obviously the "aracnoid").

Therefore, we are in front of a case of communicating external hydrocephaly caused by a failure in the reabsorption of the liquor, due to the leptomeningeal lesions, most probably hemorrhagic, of the child prince's dystocic delivery.

Of course the rickets contributed to worsening this pathological condition.

It is a well known fact that when the newly-born child is kept in supine position, the load is mainly distributed along the back and the occiput.

Rickets can generate a shorter antero-posterior diameter of the skull with flattening of the occipital curvature *(brachycefaly)* as well as floppiness of the vault along the base *(platybasia)*.

Furthermore, the faulty calcification of the osseous matrix at the level of the sutures induces their persistence and prevents closure of the fontanelles; for example, the bregmatic fontanelle, that normally closes at 18-20 months of age, can even remain open until the age of 3 years.

It follows that the skull becomes larger than normal and that a hydrocephalus can develop. These alterations can be associated – as occurred in the case of don Filippino – with *craniotabes*, namely the formation of areas of thinning and rarefaction of the cranial vault due to the reabsorption of the calcified matrix under the effects of endocranial pressure.

Alessandro Allori (1581?)
Madrid, Prado Museum

However, the hydrocephalus of don Filippino was not responsible for any neurological symptoms, a part perhaps the "attacks of nerves" and the "convulsions" reported in his clinical history. His psychic development was normal until his premature death which was caused by an acute fever infection of unknown aetiology.