Applying CT-scanning for the identification of a skull of an unknown archaeological find in Peru

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Abstract: - The 2016 finds of Palpa, Ica, Peru, assumed to be archaeological in nature, recently received due attention by the scientific community. To help clarify the issue, the current study aims to scientifically examine, through CT-scan analysis, the skull of one of the small bodies, and compare it to the braincase of llamas and alpacas, which are common animals of Ica, Peru. To this end the skull was divided into many sections and a detailed analysis was performed for each one of them. It was shown that the head of the small body is largely made of a deteriorated llama braincase and other unidentified bones, and greatly resembles the human cranium. Specifically, the remains of the skull were shown to be of biological nature, consisting of very thin greatly deteriorated bone with parts such as the mouth plate that could not be identified and recognized. Hence, the obtained results offer a new perception of the lama deteriorated braincase physiology and its resemblance to a human-like face. An additional examination of the neck of the body was also conducted, showing that there are three cords in the neck that may either be actual veins or vegetable strings or intestines for fixing purposes. Based on the above, it seems that the finds are constructions of very high quality. This makes one wonder how these have been produced hundreds of years ago (based on the C14 test). It must be said that the current study is limited by the low CT-scan resolution and the lack of more comparisons with other small bodies craniums. Consequently, more tests with C14, DNA, CT-scans at higher resolutions, and even an autopsy are needed for extracting rigid conclusions. Such work has been undertaken by the San Luis Gonzaga National University of Ica, where the finds remain.

Key-Words: - Palpa Ica, CT-scan, mummy, llama, braincase

1 Introduction

An ongoing investigation, taking place since October 2016, concerns some extraordinary finds that surfaced near Palpa in the Ica area of Peru. The investigation is contacted by the Inkari–Cusco Institute and is supported by an international experts' network [1]. Some of the finds were first presented to the Institute by "Luis Quispe", aka Paul R. These included mummified stuff of a small "body", 25cm-long, and a "gigantic hand" consisting of three fingers with six phalanges and metallic implants.

More finds were later brought to the attention of the study group by "Mario", the leader of the huaqueros (tomb raiders of Peru), at the place of discovery. These underwent a preliminary examination. The finds include a number of small "bodies" of various sizes, a large human-size mummified body, a "child" mummy, gigantic hands, small "heads", and more. In 2017-2018 Gaia, a member-supported media network, first reported the case regarding the finds in the form of documentaries (the episodes can be watched free at [2]). In addition, the case was also reported by local and some international media.

Because of the controversial nature of the finds and the social status of the persons who discovered the finds, great mistrust surrounded the case. Although the Peruvian Ministry of Culture was officially informed about it (January 10, 2017) and was asked to intervene for protecting the finds and the archaeological site in the Nazca area, it did not show any interest. On the contrary many arguments were presented in favor of fraud by many detractors. The Ministry of Culture, through the public prosecutor in charge of judicial affairs, later filed an unsuccessful accusation against "destruction of cultural property".

On November 19, 2018, under the auspices of the Peruvian Congressman Armando Villanueva Mercado, the Inkari–Cusco Institute and a group of scientists, presented the results of their analyses performed on Palpa's biological finds, at the Congress of the Republic of Peru. They defended their thesis that the "bodies" are authentic, and the finds are archaeological in nature.

From the archaeological aspect, in Peru and neighboring countries, tridactyl beings are depicted in paintings or engravings in stone, in ceramics, in textile art and so on. The depictions include small anthropomorphic beings with three fingers in each hand and peculiar heads [3], [4], [5]. Certain logical questions arise as to (i) why such beings were drawn by the cultures in pre-Hispanic antiquity, (ii) whether the tridactyl beings were regarded as spirits or gods, (iii) how the depicted figures influenced human cultural development.

In Peru and neighboring countries llamas were the main animal raised for its meat. The domestication of camelids, llamas and alpacas, took place between 6000 and 5500 years ago in the central Andes and these animals played a fundamental role in the development of pre-Hispanic societies [6]. In religious centers of the region (as for example the site of Maucallacta in Pampacolca district, department of Arequipa, Peru), remains of the animals may indicate the possibility of the ritual nature of the meat consumption, such as ceremonial feasts, mentioned in written ethnohistorical sources regarding Inca customs [7]. As explained by Boden [8], ethnohistoric, historic, and ethnographic sources lead to a clear understanding of the Incan cosmology and the role llamas play in it. Llamas were sacred animals that were sacrificed to act as messengers to the gods and ancestors and thereby help manipulate the cosmic circulation of water.

New data on mass sacrifice practices during the Chimú period (about 850 AD to 1470 AD) were provided with the discovery of the remains of 140 children and 206 camelids sacrificed at the site of Huanchaquito-Las Llamas, on the northern coast of Peru [9]. Recent ethnohistorical and ethnographic data show that old ritual practices continue to the present at some places. The llama is the only animal that may be consumed at special events, such as funerary meals or propitiatory ceremonies. The heart and the lungs of a sacrificed llama are offered, burned and symbolically consumed by the Apu (spirits of the mountain), the Pachamama (the Earth Mother) and the Tio (tutelary divinity of the mine) [6].

With the above information in mind, it is not peculiar that pre-Hispanic cultures had a special relation to llama and would refer to a human-llama spirit in an adorning and honoring manner. Consequently, the transposition of animal parts on skeletal material could possibly be an operation carried out and used by priests to support and strengthen their powers.

Examinations on the found "bodies" were carried out by a multitude of international specialists on X-rays, scanning, DNA and Radiocarbon (C14) analysis in ten countries across the world [1], [10], [11]. The examinations showed that the "bodies" may be real biological material and, despite all controversy surrounding the case, no evidence of fraud has been established. A chronological recording of important events regarding the case and all the results of the various examinations performed are available on the Alien Project website at: https://www.the-alien-project.com/en/ [1].

On November 6, 2019, a press conference was organized at San Luis Gonzaga (SLG) National University of Ica, where the University officials announced that they were in possession of four of the "Nazca tridactyl (three-fingered) mummies" (namely, "Maria", "Wawita", "Albert" and "Victoria"), and launched an international call for researchers from around the world to join them in the scientific study of these mysterious relics. Also, the University, for the first time, exhibited the mummies to the general public in protected glass cases.

Despite the controversy surrounding the case, we believe that a serious scientific investigation should have taken place by the responsible Department of Archaeology of Peru from the first moment the finds surfaced, since this group of "bodies" were not encountered before and do not resemble any known form. Important information was lost because of the passage of time, the wrong manipulation of the finds and the rumors circulating around. One, on first sight, could assume that:

(a) The finds are some kind of "ceremonial" artifacts produced in the past. If this is the case, it is of great interest to the archaeologists to study and give answers as to why they were produced.

(b) The finds were assembled from different parts of various existing animals. The recent history of Peru shows that there is a manufacturing industry of fake archaeological artifacts. These artifacts are sold to unsuspected tourists as ancient finds. Archeologist should be aware whether the finds are recent fakes or not, in order to understand the extent of capabilities the huaqueros possess, and avoid traps.

(c) The finds are real 'animal' entities, unknown to science so far. In this case, it should be of paramount importance to biologists to study the bodies and give answers as to their existence, line of evolution, and so forth.

The present study refers to one of the seemingly mummified small "bodies", named "Josephina" (Fig. 1), for which a high definition CT-scan, performed by the Inkari–Cusco Institute [1], was made available to the present group of researchers. It is noted that "Josephina" is one of seven similar "bodies" that have surfaced so far from Palpa's site. "Albert", "Victoria", "the family (of three)" and a later addition "Luisa" (which at present is in possession of the SLG National University of Ica) are the other similar ones.

Fig. 1. Front and side view of "Josephina" with a metallic plate in the chest and four ovoid objects in the abdomen

Josephina's body, 58.50cm in length, was characterized as "humanoid reptile" with hands of three fingers comprising three phalanges and claws, feet of three toes comprising three phalanges, nine pairs of ribs plus two pairs of floating ribs, and hollow bones. There is a single bone in the place of the ulna and radius pair and a single bone in the place of fibula and tibia pair. Josephina is a "female" specimen, probably in gestation, with the presence of three ovoid objects – probably eggs with embryos – in the abdomen. It also has a metallic implant at the chest with a composition of 85% copper, a composition consistent with an object from the pre-Columbian period. The whole "body", as all finds, was covered in white powder that, when analyzed, was shown to be diatomaceous earth. Dating by C14 on samples of "Victoria" showed a chronology between 950 AD to 1250 AD, while DNA analyses showed a 14–36% common material with Homo Sapiens [1].

We believe that if the above results are correct, they will have great implications to science as they will show:

1. whether indeed an unknown species of animal did exist at Peru;
2. whether animal parts were joined together to produce a puppet for ceremonial use or power
3. the extent to which people's imagination and creative art can reach

Hence, examining Josephina's remains in greater detail and care can answer the above conjectures.

In this paper a thorough description of the head and neck of Josephina is presented. The head is compared to the braincase of llamas (llama glama) and alpacas (llama pacos), which are common animals living in the areas of Ica, Peru. In doing this, the paper: (i) gives a new perception of the lama deteriorated braincase physiology and (ii) proves its resemblance to a human like face, and (iii) proposes how the cultures used the bones to express art or religious beliefs.

2 Method

The study uses the data obtained by a CT-scan of Josephina at a spacing of x=0.6210, y=0.6210 and z=0.8010254, with dimensions 515mm × 512mm × 794mm. The CT-scanning was performed at the Hospital Regional de Cusco on 7/8/2018 and each image is of size 180.62mm x 180.62mm, 512 KB. The CT-scan is owned by the Inkari–Cusco Institute and can be obtained from this source.

A CT-scan of the head of a llama, together with 3D imaging of alpacas were also necessary for comparison purposes. The CT-scan of the llama was downloaded from the DigiMorph webpage [12] and an alpaca STL file from the Anatomical Guides, Haley D. O'Brien, PhD webpage [13]. Osteological details of llamas for reference, as well as for nomenclature and comparison purposes can be found in [14], [15], [16]. In particular, Hathcock et al. [14] performed a CT on the head of six adult llamas that allowed evaluation and identification of the anatomy of the head. Lynch et al. [15] described a well-preserved camelid from South America, leading to the identification of the bones of the skull with their nomenclature. Concha-Albornoz et al. [16] gave a detailed nomenclature and figure interpretation concerning the anatomy of the osseous structures of the external acoustic meatus, tympanic cavity, and tympanic bulla of llamas.

Throughout the paper the various views were produced by Inobitec DICOM viewer [17], using the llama CT-scan and STL files and the alpaca STL file. Inobitec DICOM viewer is an excellent image reproduction software with easy editing operations and production of 3D models and Autodesk MeshMixer [18], a state-of-the-art software for working with triangle meshes.

3 General description of the head

The head of Josephina is covered in skin, as the rest of the body. Its dimensions, indicated in Fig. 2(a), are 114mm in length by 69mm in width (at a section height from the cheek of 30 mm) and 69.5mm in total height.

If one tries to match the skull of Josephina with the braincase of an existing animal, one can note that, possibly, the best match is the braincase of either a llama (about 116mm in length by 74.5mm in width by 74.5mm in height [13]) and/or an alpaca (maximum size: 100mm in length by 68mm in width by 62mm in height [19]), which may have similar dimensions and shape to that of Josephina's skull (Fig. 2(b)), although the bone thickness of Josephina is less.

Also, similar features are observed both in the internal and the external side of the skulls of Josephina and the llama braincase. As indicated in Fig. 2(b), the petrous part of the temporal bone (internal ear) shape of llama is very similar to that of Josephina's, and likewise the division border between the parietal and the temporal bone (brain case and the internal ear area). Externally, similar openings and bone features can be observed only when one removes bone material from the llama braincase so as to make it look similar to that of Josephina's skull. Figs. 2(c), (d) indicate the similarities.

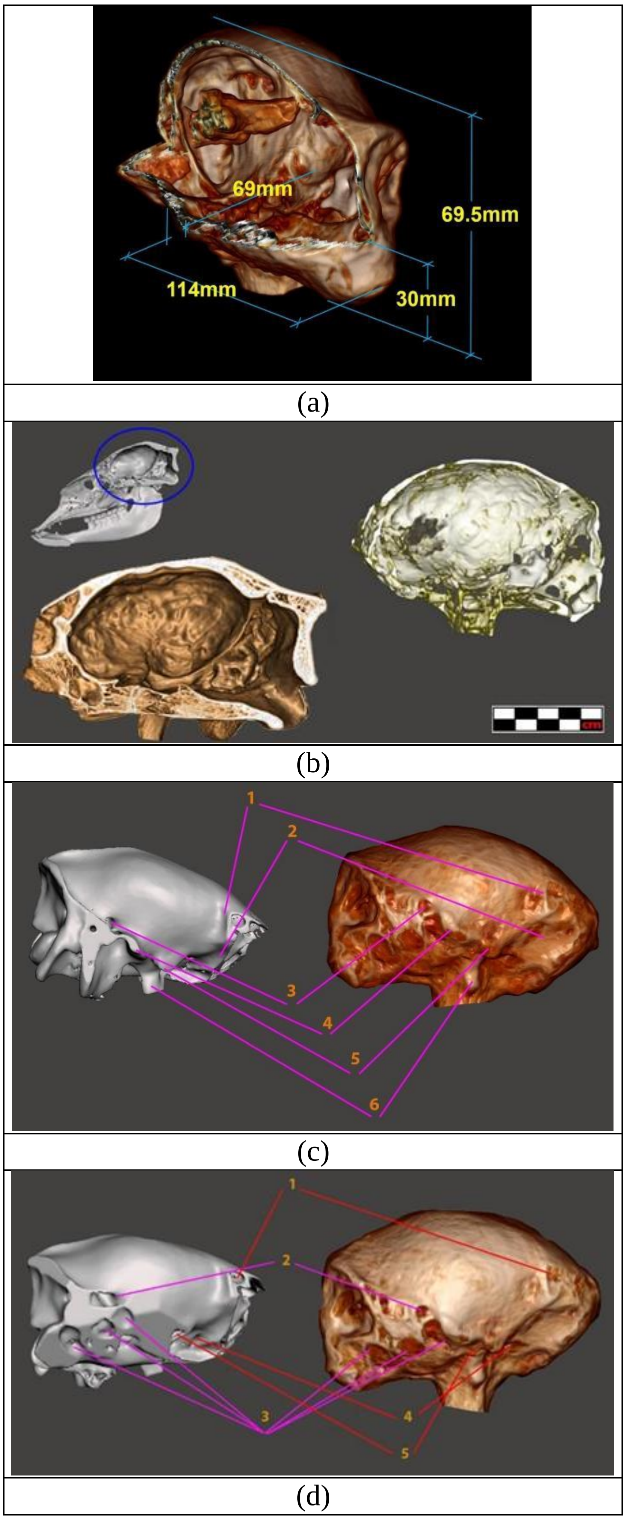


Fig. 2. (a) Basic dimensions of the head of Josephina; (b) The sagittal section of a llama braincase (left) resembles in shape that of Josephina's skull (right); (c) Lateral view of the llama braincase compared to that of Josephina's skull. Six external features that look similar are marked; (d) Further removal of material from the llama braincase indicates more similarities.

There are though features that do not correspond (Fig. 3). The braincases of llama and alpaca have a prominent ridge in the middle (external sagittal crest) that is not present in Josephina's skull. Instead, there is a groove at that place, with one additional diverging groove on each side.

Additionally, in the top front of Josephina's skull there are two symmetrical holes (Fig. 3(g), red arrows), while the suture areas in Josephina's skull, instead of being thin as in llamas, are rather thicker.

The first thought that comes in mind is that Josephina's skull thickness was reformed through a physical or chemical process. Decomposition of bone may incur depending on the burial conditions, through a chemical process; the same may result if a kind of acid is used purposely for altering the characteristics of the skull.

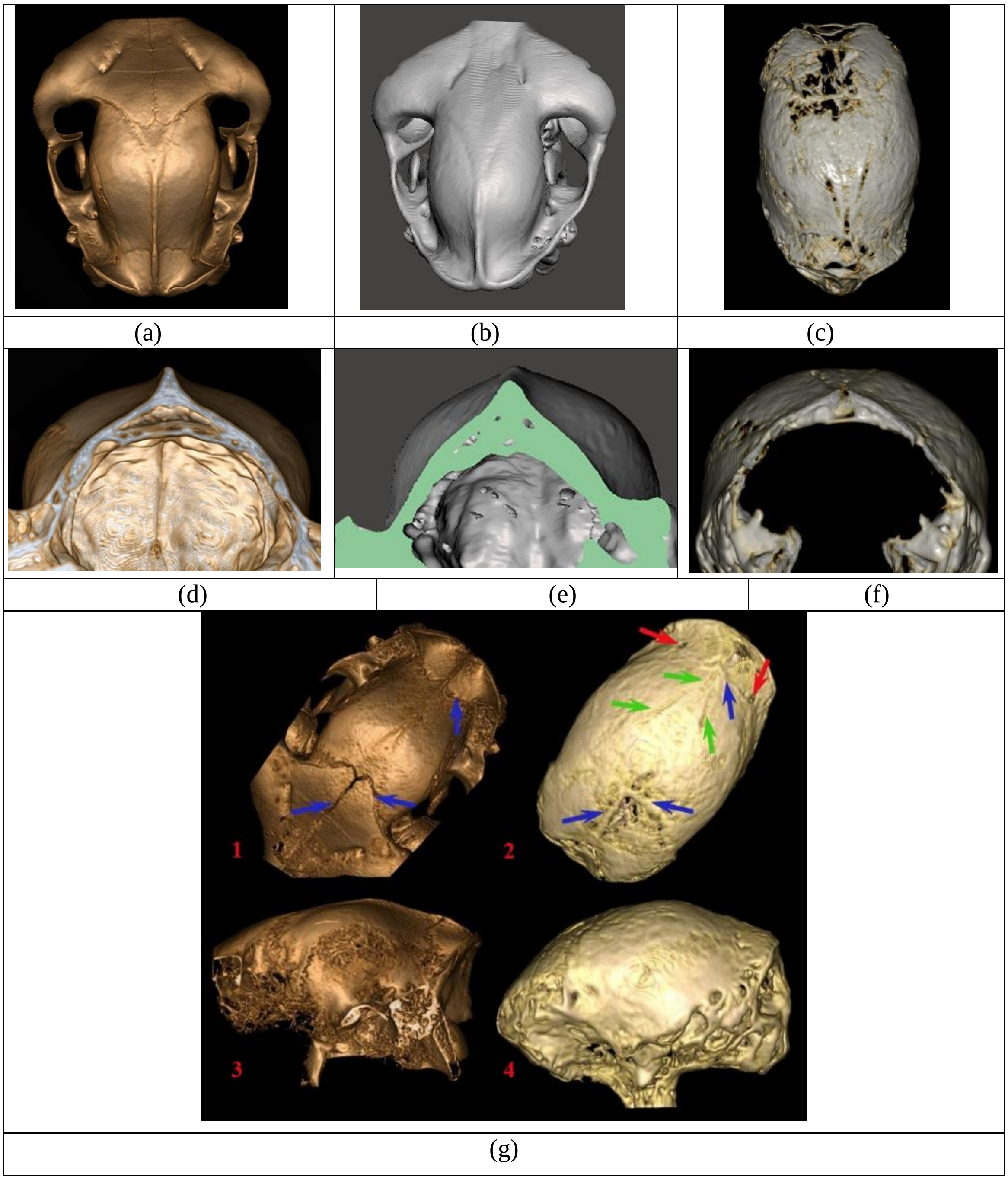


Fig. 3. Dorsal view of (a) llama [5] and (b) alpaca [9] braincases compared (c) to Josephina's skull. (d)–(e)–(f) Corresponding coronal sections showing the prominent ridge (sagittal crest) in llama and alpaca. Instead of a ridge in the middle, there are three merging grooves in Josephina's skull. (g) Dorsal view of (1) llama braincase [12], compared to (2) Josephina's skull. Red arrows indicate the two symmetrical holes on Josephina's skull. Blue arrows indicate the sutures. Green arrows indicate the three grooves on Josephina's skull. (3)–(4) Corresponding lateral views.

The part of the cranium bone that can be most easily destroyed with the above processes, is of course the spongy middle part (diploe), assuming that the wearing conditions can reach it due to some failure of the outer bone layers (laminae interna/externa).

4 Description of the mouth plates

The peculiar mouth area of Josephina greatly differs from any living organism. Fortunately, the available CT-scan thereof enables a detailed examination. The mouth opening measures 24.5mm x 27.3mm and is covered by two mouth plates, as shown in Fig. 4(a).

The two plates are covered with skin, with no obvious lips being present. The top mouth plate has a rather square opening in the middle of its lower part, which upon closer observation is covered with softer material. In a labial view (Fig. 4(b)), another deformation is present in the middle upper part of the bottom plate. This may be an indication that both plates consist of two parts (left and right) that fused together, or that the bones are thicker and harder at the opposite ends, forming a mechanism of four 'teeth'.

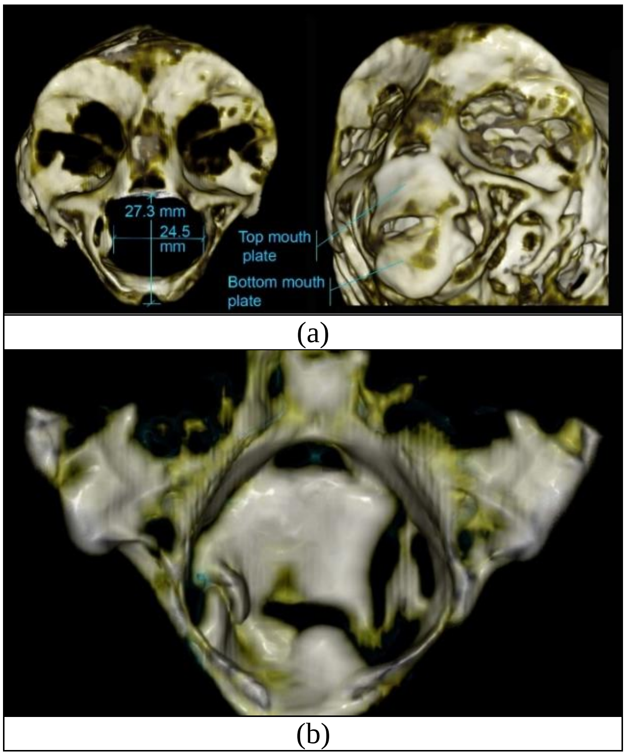
Sections at the four protrusions are shown in Fig. 5. The sections are performed in parasagittal planes 1-1 (a) and 2-2 (b), and in transverse sections 3-3 (c) and 4-4 (d), as indicated in the middle image. In (a) and (b), it is observed that both plates are thicker at their outer sides and thinner at their adjacent areas. The curvature in the shape of the plates are worthy to be noted; they are not flat pieces of bone. At their left side the two plates are joined in a specific form. In (c) the top mouth plate is thicker at the middle area of the right part. The middle of the left part is also slightly thicker. In (d) the transverse section on the bottom mouth plate shows that it is thicker at the area of the two protrusions resembling teeth.

A closer look at the top mouth plate shows that it is attached to the rest of the skeleton of the skull with hard bone at two symmetrical lines, as shown in Figs. 6(a),(b),(c).

In their left side the two mouth plates are articulated in a kind of fixed but springy joint. This type of fixed joint allows very small controlled movement of the bone, because it is fixed in the front by the bone structure, and it has guidance and a stop on the other side (Fig. 6(d)).

Regarding the right side of the mouth plates, as seen in Fig. 6(e), no relative remains are left for comparison.

The bottom mouth plate seems to be connected to the top mouth plate on the top left side when viewed from the front (Fig. 6(e)). Also, its lower right side is connected to one of the buccal plates (Fig. 6(f)).



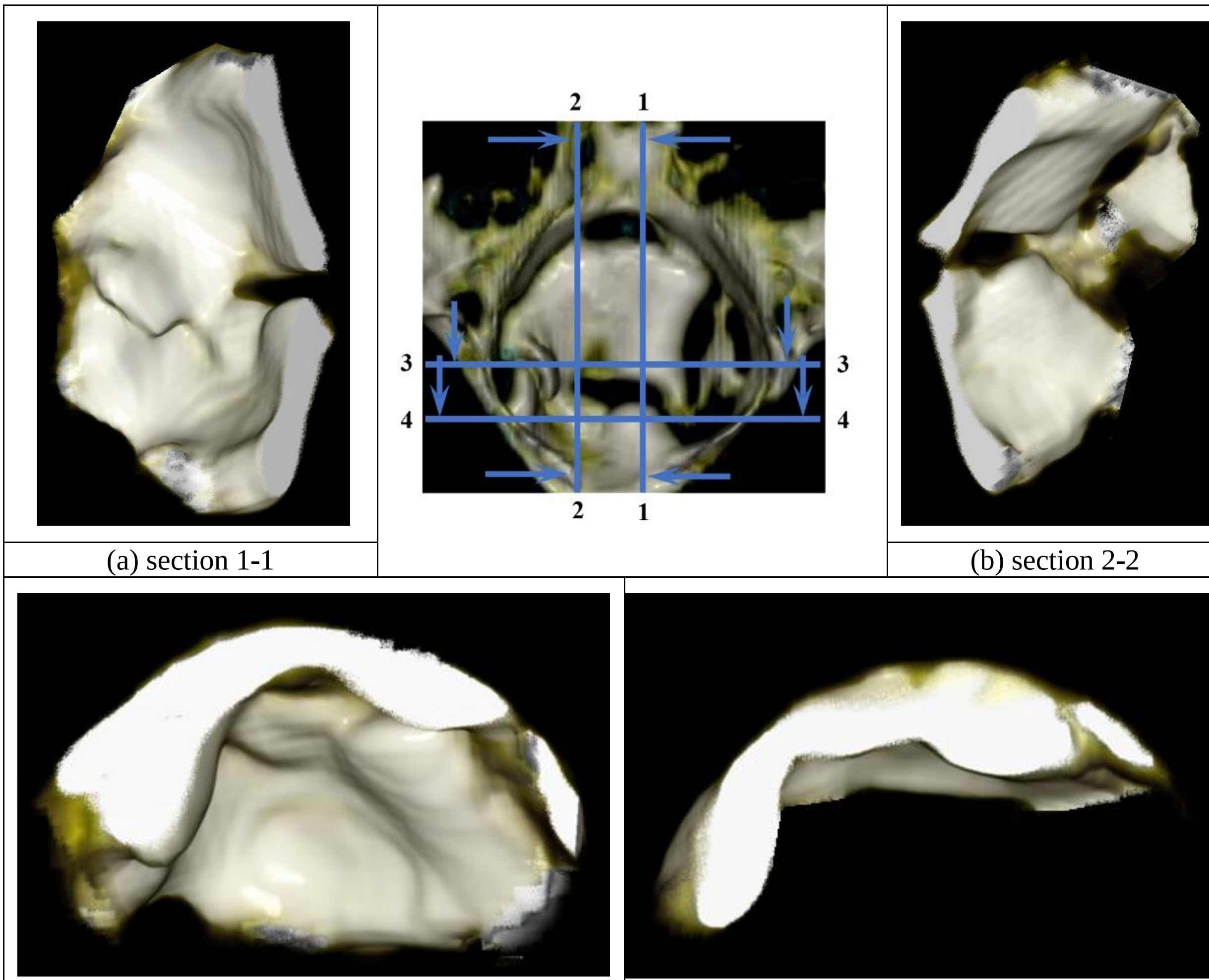
(a)

(b)

Fig. 4. Presentations of Josephina's mouth structure. (a) The left image shows the dimensions of the mouth opening and the right image the two mouth plate bones in position. Note that in parts, softer material than bone (yellow-green material) is present. (b) Labial view (showing the mouth plates from inside the mouth). It can be observed that the left side is intact at the point where the two plates are articulated in a joint (middle left). The right side is not symmetrical and is not intact. Also observe the edges of the plates, in between them, that form a similar mechanism to four teeth.

The bottom mouth plate is not connected to any other point of the skull bones at its lower end, as seen in Figs. 6(g),(h),(i). Also, in the same figure it is shown that in the middle of the lower end of the plate there is a cylindrical channel (indicated by the red arrows). The right sides of both top and bottom mouth plates are assumed to be destroyed (deterioration), as no joint between them is present.

Comparing this part of Josephina's skull to the braincase of the llama, it is observed that a similar feature is present on the occipital bone (end of tuberculum pharyngeum), as shown in Fig. 6(j).



(a) section 1-1 (b) section 2-2

(c) section 3-3 (d) section 4-4

Fig. 5. Sections of the two mouth plates: (a) in parasagittal plane, section 1-1, (b) in parasagittal plane, section 2-2, (c) in transverse plane, section 3-3 and (d) in transverse plane, section 4-4 as indicated in the middle image.

Therefore, the only “unique” feature at this part of Josephina’s skull is the mouth plates, which at the resolution of the CT-scan available, seem to be connected to the skull.

5 Description of the buccal area, nasal and paranasal areas

The two buccal sides are shown in Figs. 7(a), (b), (c), (d) in a series of images taken from different angles. The bones in the buccal areas are not of the same structure, and this can let one assume that the left side was destroyed. The missing bone of the left side is marked with pink color on the right side (Fig. 7(a)). The missing bone is the one on which the bottom mouth plate is attached, as indicated in Fig. 6(f).

The nasal area is very interesting, because it includes voids in its structure that are not directly observable on a modified braincase of an animal like llama or alpaca. In the anterior view of the nose area (Fig. 7(e)) it can be observed that there are two nostrils above the top mouth plate in between the lower end of the eyes, which are covered with a membrane at the back side. Removing the covering skin of the face, a thin bone is observed below (Fig. 7(f)). Nostril openings are obvious, along with a crest leading to a small hole at the top. Looking at this area from the back side (from inside the head (Fig. 7(g)), it is observed that a channel leads to a cavity on the top of the face (similar to frontal sinus).

Also, two vertical openings below lead inside the nose cavity, which is open at its top. Fig. 8(a) shows the two vertical openings in a transversal cross-section. In a bottom view transversal cross-section at the top nose opening, it is shown that a membrane covers the bone opening (Fig. 8(b)), while Fig. 8(c) shows a transversal cross-section of the bone opening at the top of the nose.

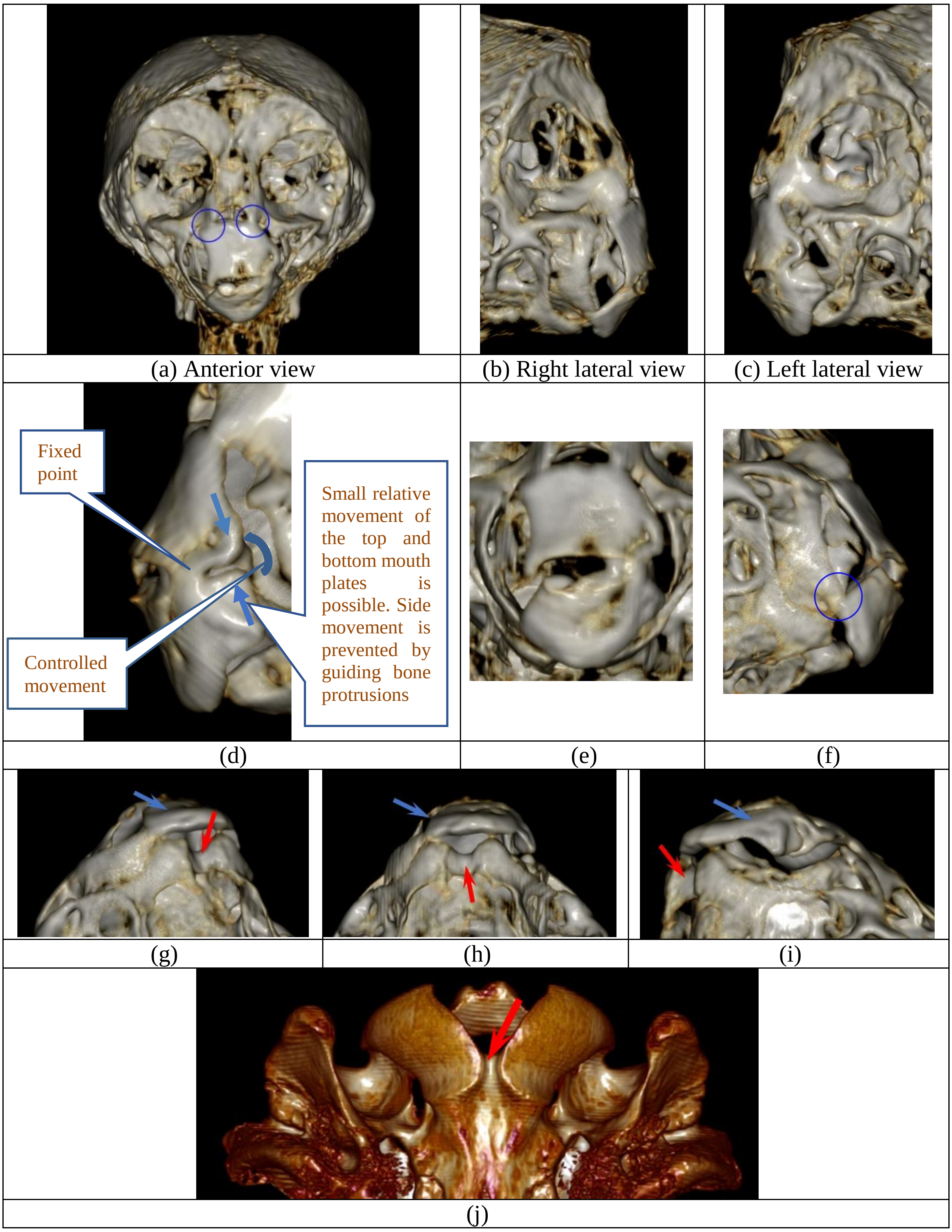


Fig. 6. (a) Anterior and (b-c) lateral views of the hard bone of skull showing that the top mouth plate is part of the face skeleton and not a separate plate. (d) Close examination of the allowable relative movement of the mouth plates. (e) The bottom mouth plate is connected to the top mouth plate at the mouth opening. (f) Shown in the circle is the connection of lower right side of the bottom plate to one of the buccal plates. (g) Latero-ventral view showing the right side of the bottom mouth plate in blue arrow. (h) Ventral view. (i) Latero-ventral view showing the left side. Also observe the cylindrical channel indicated by the red arrow. (j) Cylindrical channel (red arrow) observed on a llama occipital bone (end of tuberculum pharyngeum) resembles the feature present on Josephina's skull.

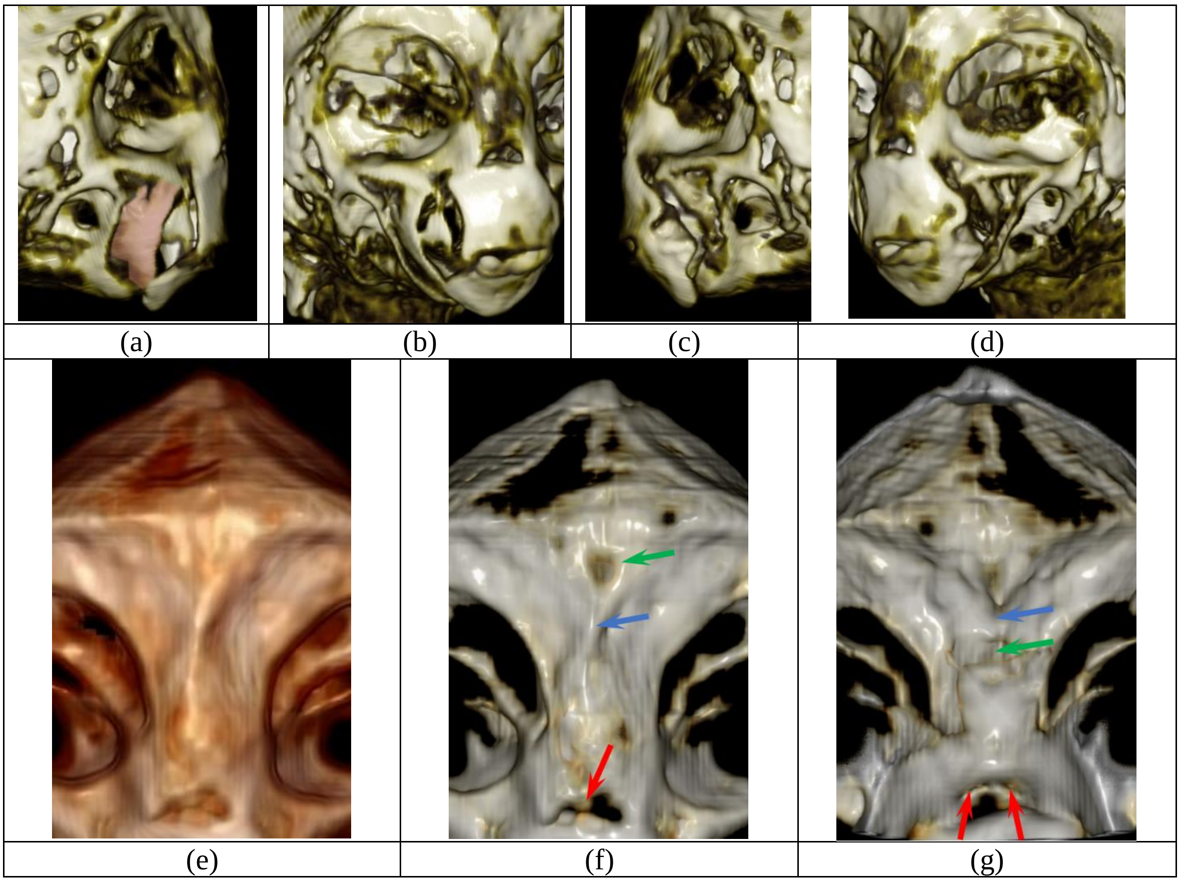


Fig. 7. A series of images of the buccal areas taken from different angles. (a)–(b) Right buccal area. In (a) marked in pink is the missing bone of the left buccal area. (c)–(d) Left buccal area. (e) Anterior view showing the nostril openings. (f) Anterior view. The red arrow indicates nostrils, the blue the crest and the green the small hole on top. (g) View from inside the head. The blue arrow shows the channel leading to the 'frontal sinus'. The green arrow shows the nose opening at the top of the nose and the red arrows the two vertical openings leading inside the nose cavity.

By removing the front part of the nose bone, in a top front view one can observe the nose back bone (Figs. 8(d), (e), (f)). There, the two nostril channels and the top opening can also be seen. Looking at the left corner of the nose back bone a slit can be seen, probably indicating to a destroyed weak bone (Fig. 8(d)). The right corner shows a small hole leading to the eye and a bigger opening at a higher level (Fig. 8(f)). Because of (a) the condition of the skull, which is probably deteriorated and consists of thin bones, and (b) the CT-scan's not so high resolution, no concrete conclusions can be drawn about the nose back bone.

At the base of the nostrils there are two passages leading to the left and right inner ear. These channels are indicated with red arrows in Figs. 9(a), (b), (c).

The description of the nose area, with its cavities and passages, is also clarified by presenting a sagittal section showing the bones and skin of the face area. Fig. 9(d) indicates the nostrils, the passage to the ears, the opening leading to the 'frontal sinus' and the cavity of the sinus with a very thin bone on top.

Could all the above observations prove that Josephina's skull is a unique biological find with anthropomorphic characteristics or can these be generated or produced in a llama skull? In general, it is observed that a llama braincase consists of external layers of hard bone with porous bone in between. In the case of deterioration (either from burial conditions or chemical treatment) the porous bone will first be destroyed. Fig. 9(e) shows a sagittal section of the llama braincase with yellow bone indicating hard bone layers, and dark orange color indicating porous material. It is seen that the 'nose' area can be cleared of the porous bone leaving an empty cavity inside, which will be open on top leading to the 'frontal sinus'. The cavity of the 'sinus' with a very thin bone on top can also be easily observed when the porous bone is removed at this place.

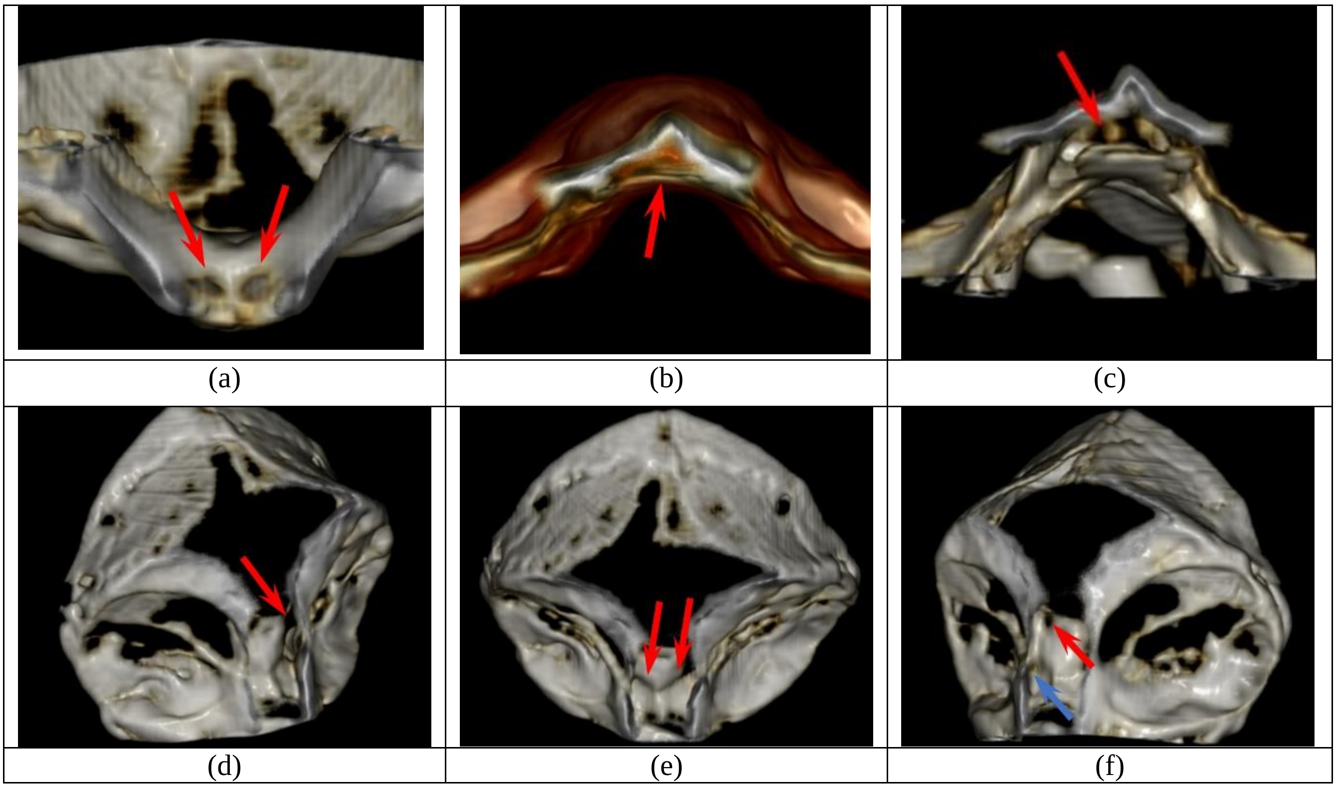


Fig. 8. (a) Transversal cross-section showing the vertical nostril openings. (b) Transversal cross-section, bottom view, at the top nose opening showing a membrane (red arrow) covering the area of the bone opening. (c) Transversal cross-section showing the bone opening (red arrow) at the top of the nose. (d)–(f)Top views showing the nose back bone. The front part of the nose bone is removed. (d) Slit in left corner indicated by red arrow. (e) The red arrows indicate the two nose channels. (f) The blue arrow shows a small hole leading to the eye and the red arrow a bigger opening.

A section of the llama braincase just above the corresponding base of Josephina's 'nostrils' (Figs. 9(f), (g)), impressively enough, shows the two 'passages' leading to the inner ears. These are filled with porous bone, which when removed, the outcome matches exactly what is observed in Josephina.

Finally, the 'frontal sinus' bone area of Josephina is presented in Figs. 10(a), (b). A very thin and deteriorated bone covers the area, with some small openings present on the suture area. As already mentioned above, the cavity in this area can be replicated in a llama braincase by removing the porous bone (see Fig. 9(e)).

6 Description of the eyes' areas

The eyes' areas of Josephina are covered with skin allowing an inclined slot for the eye opening, as indicated in Figs. 11(a), (b). The dimensions of the 'eye sockets' are approximately 24.5mm in width by 20.2mm in height.

Fig. 11(c) shows an anterior view of the bone of the eye cavity. The depression of the eye is very shallow – only about 7mm deep. The eye bone can mainly be separated in two areas. Area-1 (Fig. 11(c)), which actually forms the eye slit observed above, and Area-2, which probably consisted of thin bone that did not endure. Below Area-1 there exists another small area with thin bone that was destroyed on the right eye, but it is still present on the left. Of interest is a small hole below every eye slit, at its far end. These holes are the first that appear on a llama deteriorated braincase, as illustrated in Fig. 11(d).

The eye slits of Josephina are presumably large, as are the eye sockets, leading to the impression of a large eye – assumed to be present – that seemingly protruded by a large amount from the face, because of the shallow depth of the sockets. This, if real eyes were present, would consequently allow Josephina to have a greater angle of view.

7 Description of the occipital area

The occipital area is the most puzzling one, as there are many openings with areas of solid bone. Fig. 12(a) shows the occipital area in a lateral view.

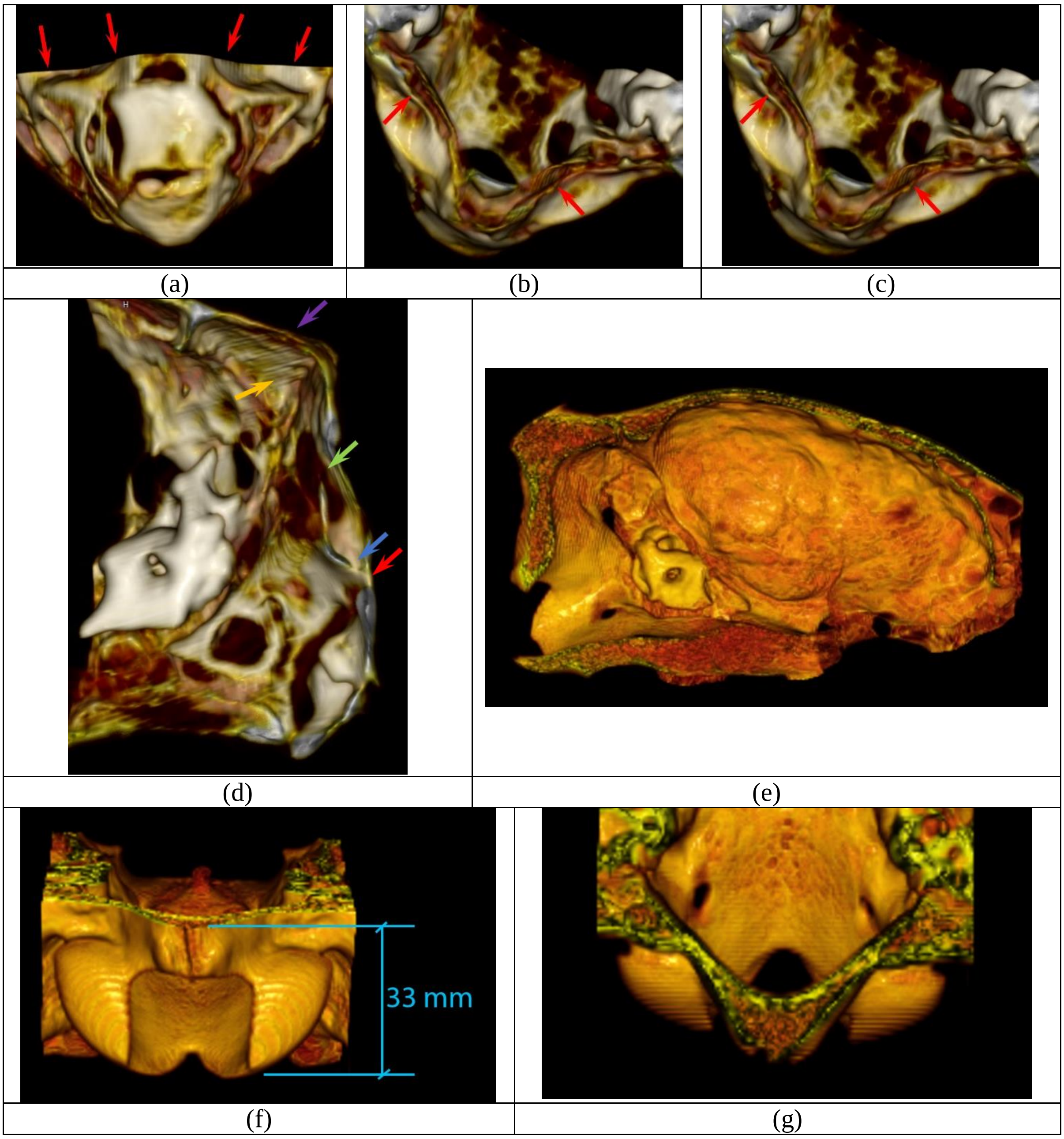


Fig. 9. Josephina's sections: (a) just above the base of the nostrils to show the position of the two passages leading to the inner ear, marked with the red arrows, (b)–(c) showing the passages from the nostrils to the inner ears (red arrows). (d) Sagittal section showing the nose area and its cavities and passages. The red arrow shows the nostril opening, the blue shows the passage to the ears, the green shows the opening leading to the frontal sinus, the orange the cavity of the frontal sinus and the violet the very thin bone on top. Llama sections: (e) Sagittal, showing the braincase. Yellow bone indicates hard bone layers (laminae). Dark red color indicates porous material (diploe). Porous bone is observed inside the 'nose' and at the 'frontal sinus' area, which actually is the occipital bone of a llama. (f) shows the position of section (g), where the 'passages' from the 'nostrils' to the inner ears are filled with porous bone (diploe).

Many void spaces in bone are observed in the outside area, and one can wonder if, in this area, there was thin bone that deteriorated, or this was the way that it was constructed.

Fig. 12(b) shows the posterior bone structure of the occipital area. As it can be observed, the area of the solid bone structure is complemented with large void areas. When the skull is sliced to allow observation of the inside structure and enhanced

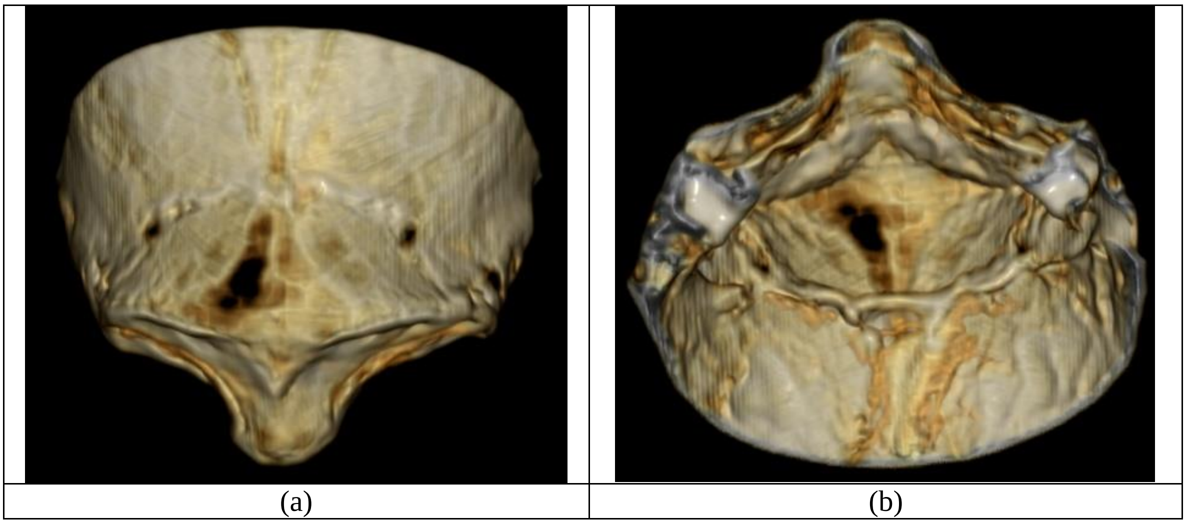


Fig. 10. 'Frontal sinus' bone area of Josephina. (a) Top view showing very thin and deteriorated bone. (b) Reverse side.

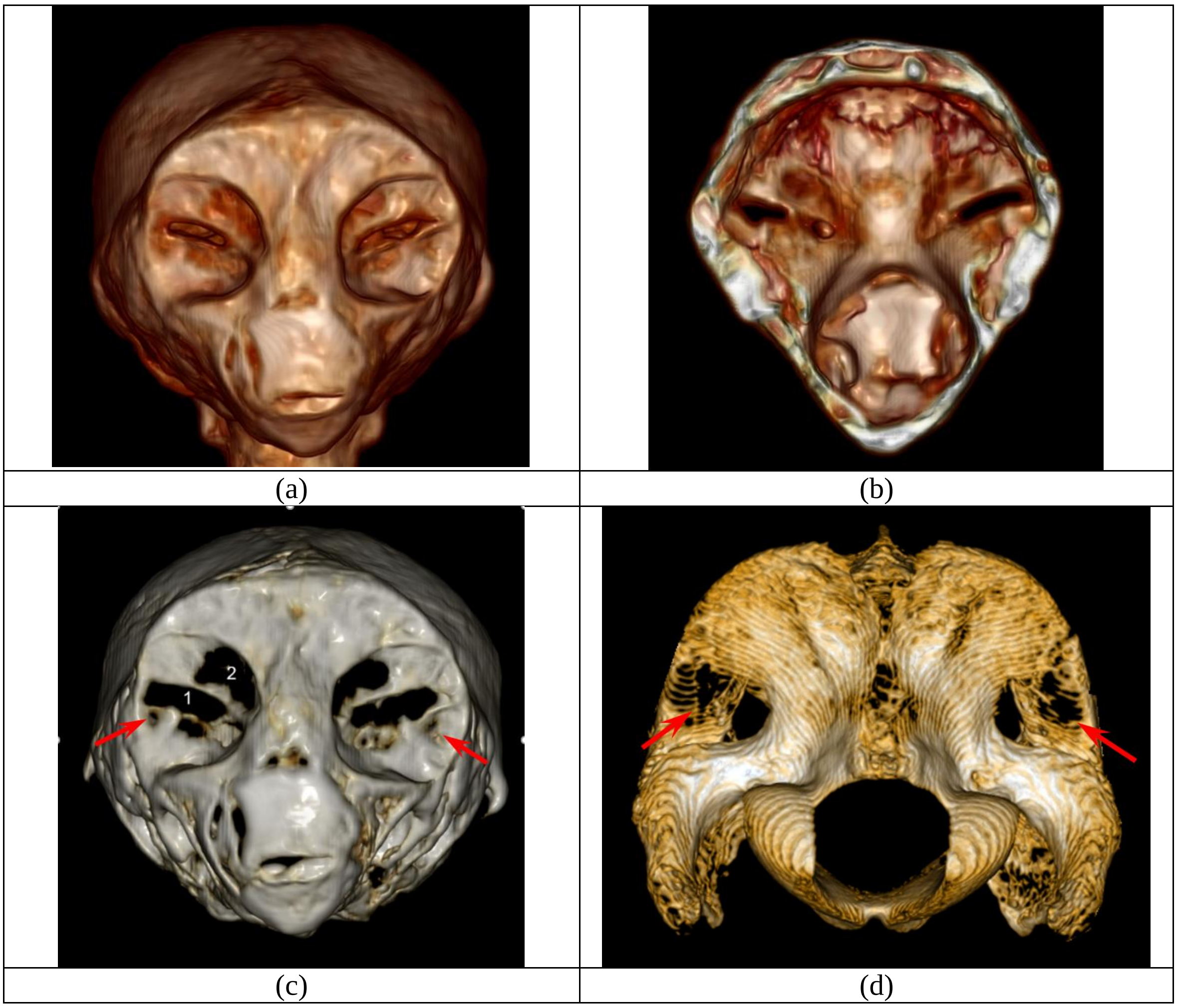
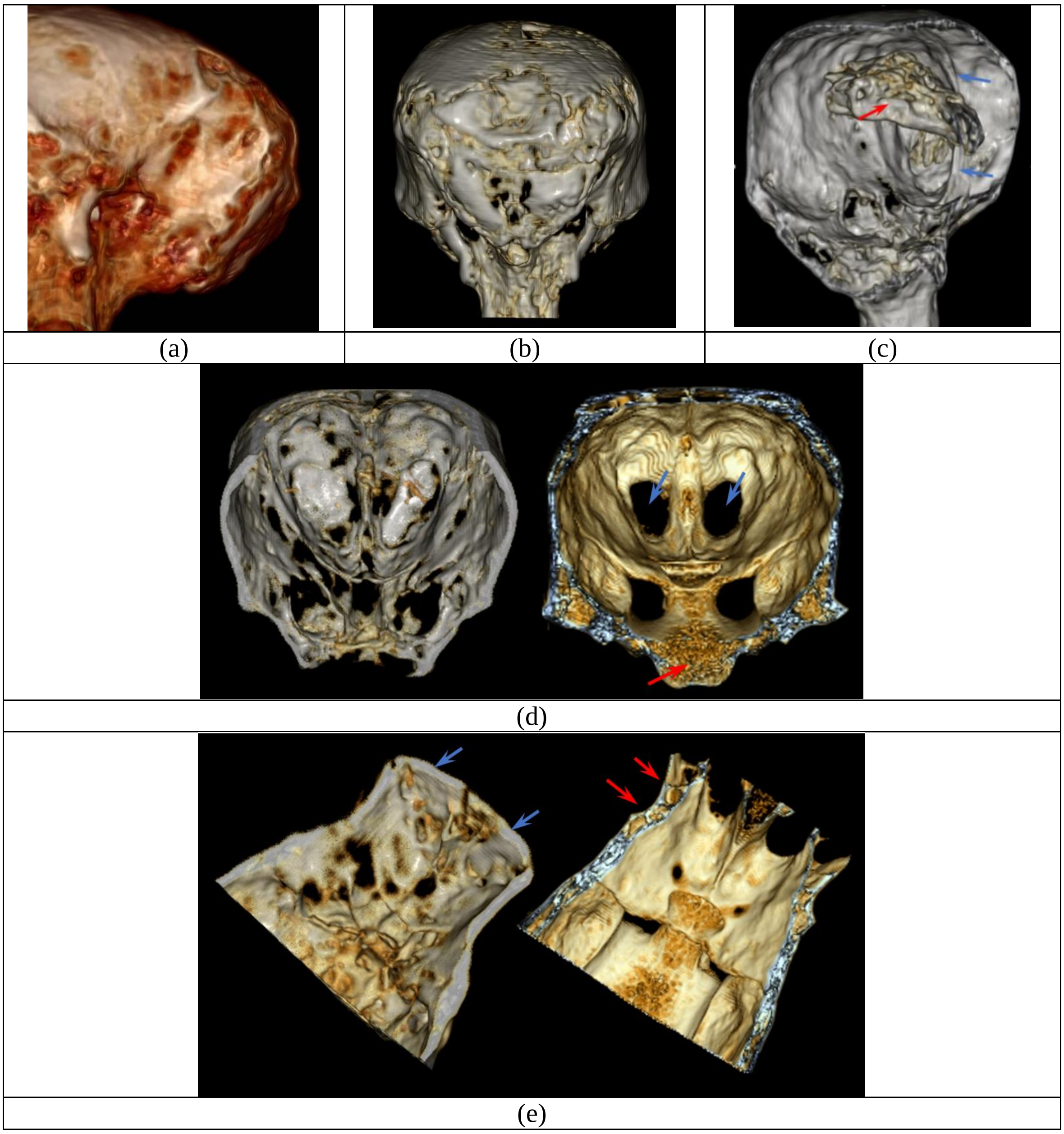


Fig. 11. Eyes' Areas. (a) Anterior view. Skin coverings of the eyes' areas of Josephina allowing an inclined slot for the eye opening (b) Corresponding view from inside the head-Labial view. (c) Anterior view of the eye area of Josephina. Area-1 is the slit; Area-2 probably shows deteriorated bone. The red arrows indicate two symmetrically placed holes. (d) On a llama deteriorated braincase, the two holes, indicated by the red arrows, are the first to appear.

to observe softer biological material (Fig. 12(c)), one can see that remains of the brain are present. Also, the two hemispheres at the back are separated in the middle with bone structure. A detailed comparison of the occipital area between the remains of Josephina and a llama braincase shows some similarity in shape. There are though areas (Figs. 12(d), (e)) that are dissimilar, as for example the openings of fossae ethmoidale of llama do not exist in Josephina (they are covered with solid bone).



(a) (b) (c) (d) (e)

Fig. 12. Occipital area of Josephina. (a) Lateral view showing empty spaces in bone-dark tones. (b) Posterior view of bone structure. (c) Section of the skull allowing observation of the inside structure and enhanced to observe softer biological material; the red arrow shows remains of the brain and the blue arrows show the separating bone structure in the middle. (d)-(e) Side by side comparison of a section through the skull of Josephina (left) and llama (right). (d) Coronal section. The blue arrows show cavities on llama (fossae ethmoidale), which do not show on Josephina. The red arrow indicates thick spongy bone on llama, not present in Josephina – probably deteriorated and gone. (e) Transversal cross-section. The blue arrows show bone on Josephina's skull not present on llama. The red arrows indicate a great dissimilarity of the llama bone compared to that of Josephina at this point.

8 Description of the ears

Josephina's skull remains do not indicate any outer ears. Also, the bone structure around the position of the inner ear shows many openings, which are rather due to deterioration of the bone structure. These openings can be observed in Fig. 13(a), where even the inner ear otic capsule can be seen in a lateral view in one of the openings. In a transversal section one can observe the positions of the otic capsules of the internal ear (Fig. 13(b)).

As mentioned above, at the base of the nostrils there are two passages that join the nostrils to the inner ear. These passages can also be observed in Fig. 13(c), together with the deteriorated area around the bone capsule of the inner ear, presenting a large empty area.

A comparison of the shape of the otic capsules, between Josephina's and a llama's, shows a similar outer shape. Even sections in different planes show that the structure of the inner chambers of the capsules of Josephina and llama are identical (Figs. 13(d), (e), (f), (g)).

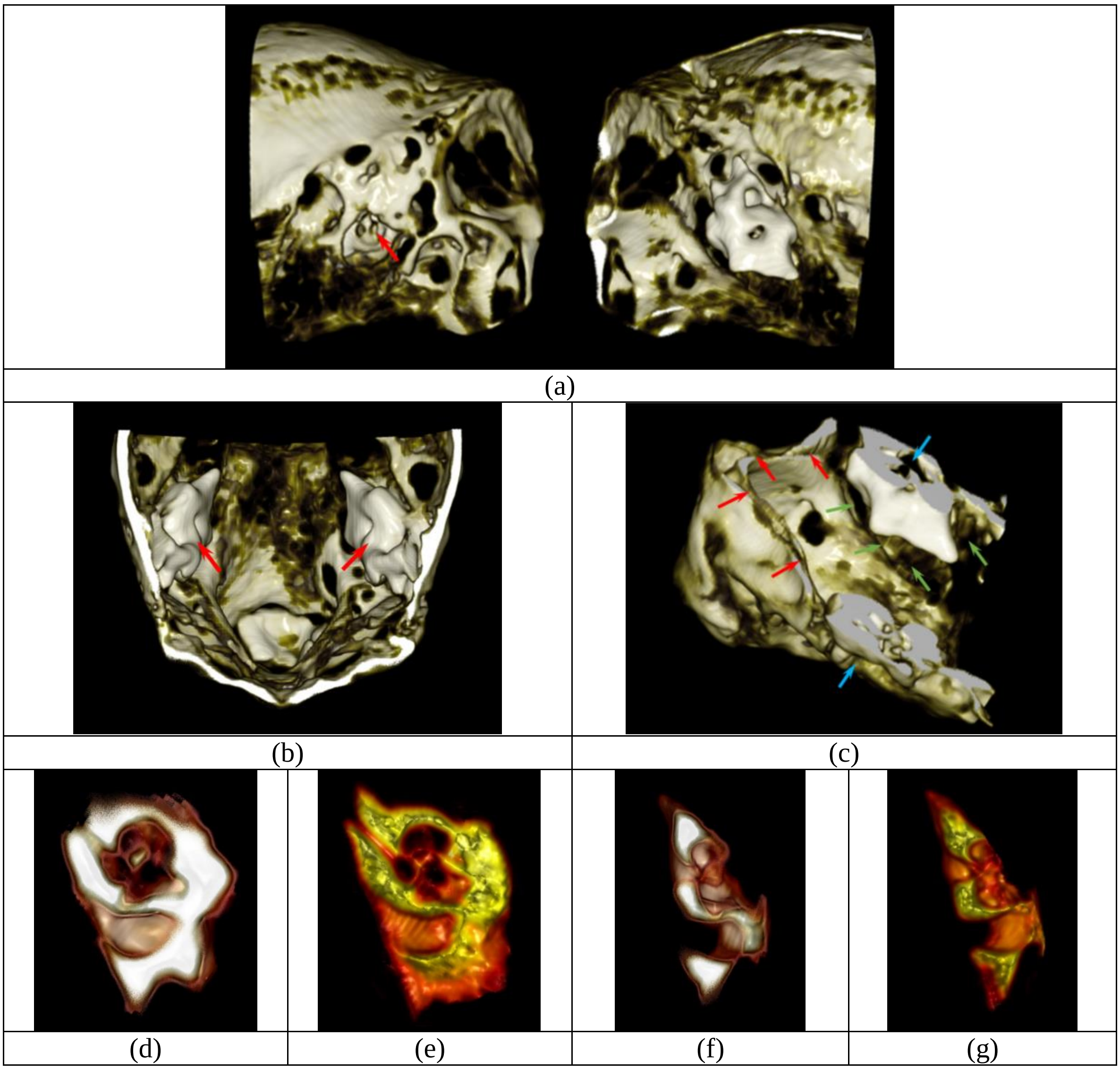


Fig. 13. (a) Skull of Josephina (Left) Lateral view corresponding to the area around the inner ear otic capsule. The red arrow shows the capsule inside the skull. (Right) Sagittal section showing the capsule from the inside. (b) Transversal section showing the positions of the otic capsules of the internal ear (red arrows). (c) Transversal section where the red arrows show the two passages that join the nostrils to the inner ear. The green arrows show the large empty area around the otic capsule of the inner ear. The blue arrows show the deteriorated area of the skull, allowing unrestricted view of the bone capsule. (d)–(e) Inner ear otic capsule sections showing the internal features. Josephina's sections (d, f) are similar to the llama's (e, g).

Cutting deeply into the bone of llama to uncover the inner ear, and upon comparing the cut area with Josephina's corresponding part, it is observed (Fig. 14) that there appear two cavities next to the ear cavity, one in the back of it and one in the front. Even the occipital condyle laminae of llama can form two of Josephina's buccal plates, if the spongy middle layer – the diploe, is deteriorated. All the above, reinforce the scenario that Josephina's skull is a modified llama braincase.

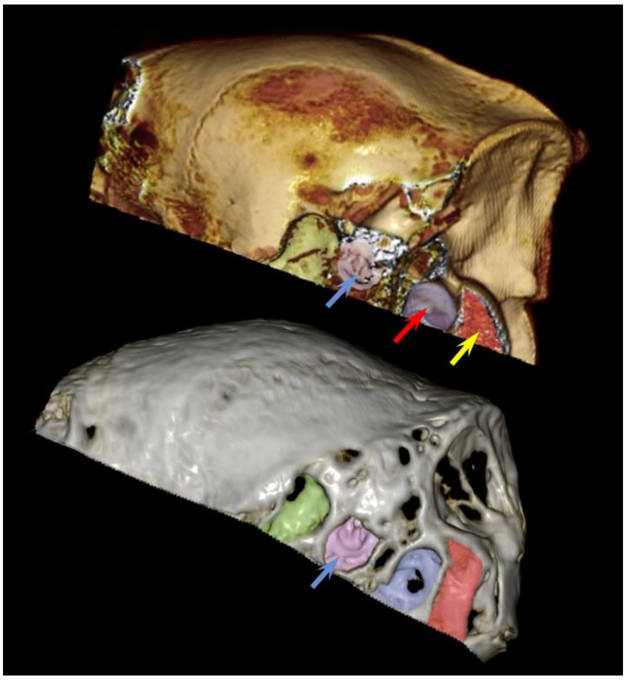


Fig. 14. Comparison of cavities in front and back of the ear cavity in llama (top) and Josephina (bottom) indicates great similarity. The ear cavities are indicated with blue arrows. The red arrow shows the ventral condyloid fossa, and the yellow arrow the occipital condyle in llama.

9 Description of the underside area of the head and neck

The underside area is very interesting and needs extra attention, in order to further explain the remains. An overall ventral view of the head bone is shown in Fig. 15(a). Also shown in Fig. 15(a) is a superior view of a transverse section indicating the bones from the other side. It is observed that the bone is generally deteriorated, with large parts being thinned or destroyed. When a transversal cross-section just cutting the underside of the basicraniums of Josephina and llama are viewed inferiorly, differences are observed at the area around the joint of the neck vertebra with the skull (Fig. 15(b)).

The main underside bone of Josephina is very thin – in construction – between the mouth articulation and the neck, and from the neck to its end. Compared to a llama basicranium, the front shape and thickness exhibit some differences (Fig. 15(c)). These differences, though, could be explained through acceptable variations within a species.

In a superior view of a transversal cross-section one can name the basic openings of the braincase of llama, as indicated in Fig. 15(d). The same features can also be observed on Josephina's skull. It is observed that an orbital fissure (the passage of the ophthalmic nerve to the brain) and an optic canal (the passage of the optic nerve to the brain) can also be found on Josephina, although Josephina's eyes are supposed to be on the opposite site of the skull.

Also, it should be noted that the oval foramen is the passage of the mandibular nerve V3 for the mandibular division and chewing. The orbital fissure in llama is the passage of not only the ophthalmic nerve but also: the oculomotor nerve (III) that controls 4 of the 6 muscles of the movement of the eyelid and the constriction of the pupil; nerve VI (abducens) controlling eye movement; nerve IV (trochlear) that is the motor to the superior oblique muscle of the eye. All the above make no sense at the place they are found for Josephina, and this definitely proves that Josephina's skull is an articulated braincase of llama.

Still, to further obtain a deeper insight of the whole structure of Josephina's articulation of the skull to the rest of the body, we examine the articulation of the cranium to the first cervical vertebra (Fig. 16(a)). Actually, the fact that the 1st cervical vertebra enters the basicranium of Josephina would discourage any serious researcher to investigate further, because it would show that the remains were articulated from various bones, fitting together in a mechanistic and unfunctional way. The cervical vertebrae in Josephina should destroy the brain if there was a downward impact on the head, because in the absence of any visible stopping mechanism the vertebrae would enter the braincase.

Further, it is observed that the cervical vertebrae of Josephina are made of softer material, probably cartilage, which can be completely removed with the viewing software, thus allowing only bone to be shown. On first sight (Fig. 16(b)), one can say that the occipital condyles, left and right of the foramen magnum, compose a kind of positioning device to the 1st vertebra without allowing it to move inside the cranium. On a closer look (Figs. 16(c), (d)), the shape of the occipital condyles of Josephina show great similarity to deteriorated condyles of llamas, especially to the side 'breaks' that appear on the edges.

A coronal section showing the cervical vertebrae in articulation with the occipital condyles of Josephina is shown in Fig. 16(e), in comparison to the corresponding area of llama in Fig. 16(f). It can be seen that there is similarity of the hard bone layers (laminae) of llama considering that porous material (diploe) is deteriorated and gone.

Details of the cervical vertebrae can be observed in transversal consecutive sections. In Fig. 16(g) one can see the top surface of the first cervical vertebra. It is covered with skin, and a type of cord (tissue?) is seen protruding from the surface and extending into

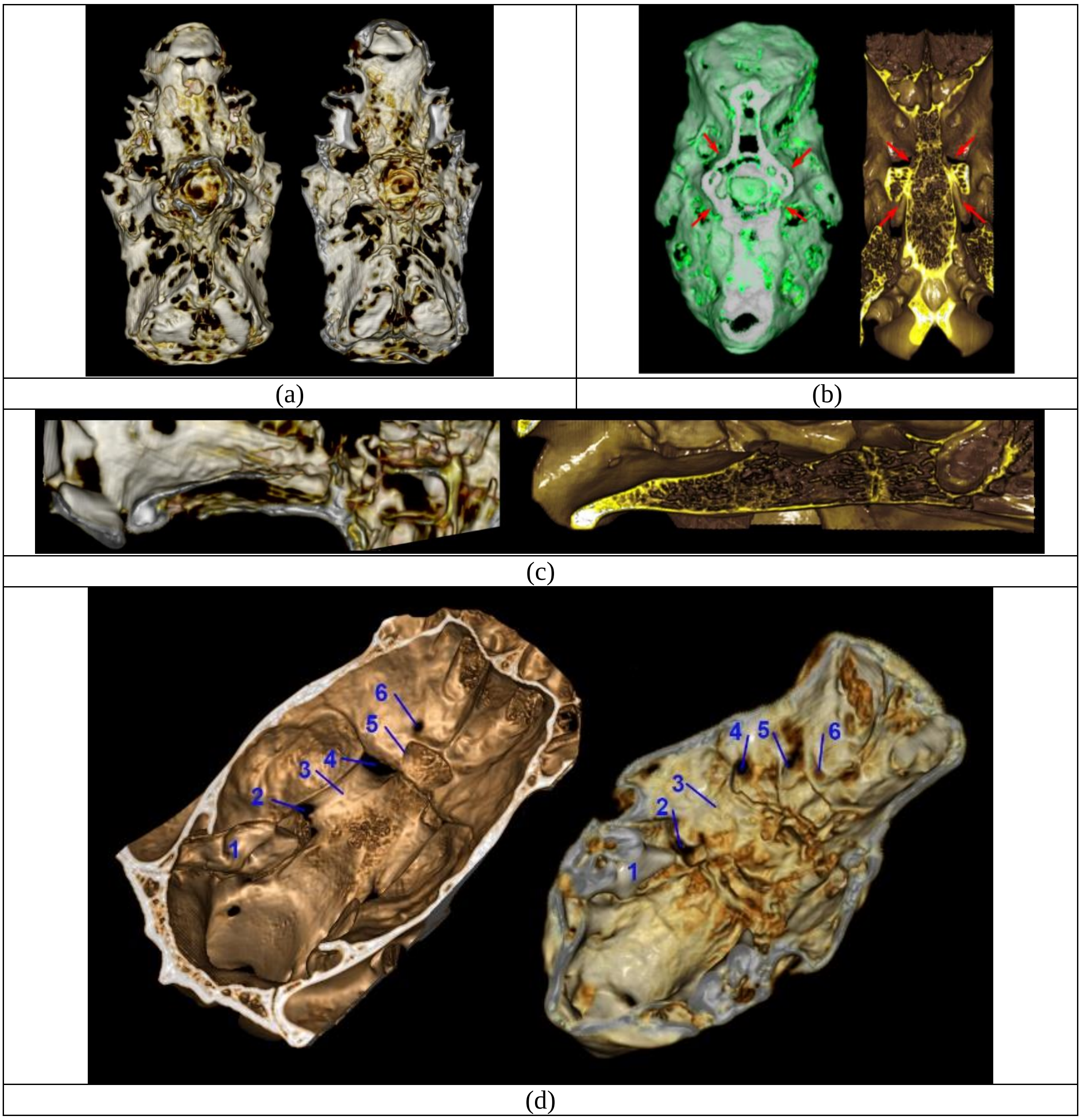


Fig. 15. (a) Left, General ventral view of the head bone. Right, Superior view of a transverse section showing the bones from the other side. (b) Inferior views of transversal cross-sections just cutting the underside of the basicraniums of Josephina (left, in false color) and a llama (right). The differences are indicated by red arrows. (c) Sagittal section of Josephina's basicranium (left) compared to a llama's (right). The front shape and thickness show some difference. Also, observe the greatly deteriorated bone of Josephina, a spongy bone in llama. (d) Superior view of a transversal cross-section of the braincase of llama (left) and Josephina's skull (right). Main features are: 1 – Petrous part of the temporal bone (otic capsule). 2 – Oval foramen. 3 – Sinus sphenoidalis. 4 – Foramen rotundum. 5 – Orbital fissure. 6 – Optical canal.

the brain case. The next section (Fig. 16(h)) is at the bottom side of the basicranium. Observed is the trace of an angled bone that is not present in a llama. The shape of the vertebrae is round, about 10mm in diameter, with a groove at their posterior in which the cord is positioned. The same structure of the vertebrae continues further down.

In a sagittal section (Fig. 17) four cervical vertebrae are shown to be present with varying thickness of about 8–9mm.

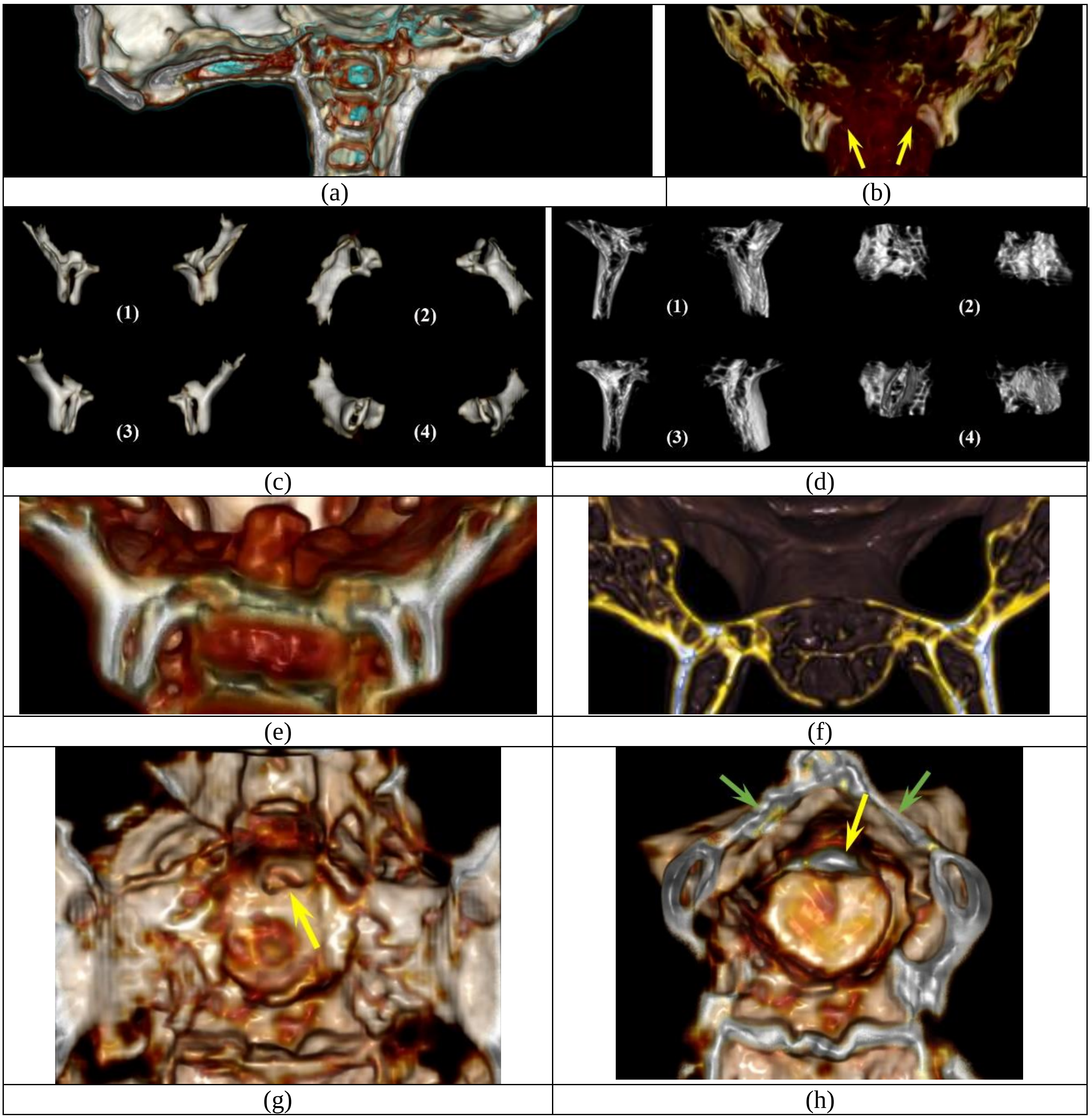


Fig. 16. (a) Sagittal view, in false color, showing the cervical vertebra and their articulation to the cranium. (b)Antero-inferior view of the occipital condyles. Indicated with yellow arrows is the positioning and stopping feature. (c) Occipital condyles of Josephina and Lama (d), viewed from various angles. (1) Inferior view. (2) Superior. (3) Posterior. (4) Anterior. Coronal section showing: (e) the cervical vertebrae in articulation with the occipital condyles of Josephina; (f) the corresponding section of llama showing the occipital condyles. (g-i) Transversal sections of the cervical vertebrae. (g) Top surface of the first cervical vertebra. (h) Section just below the bottom side of the basicranium. The yellow arrows show a type of cord (tissue?), the green arrows show traces of an angled bone connecting the cervical vertebrae.

A cord obviously runs the whole length of the neck and enters the vertebral cage, together with two other cords coming from the anterior part of the neck. The nature of the cords cannot be identified with the available CT-scan only, but further investigation is necessary. They may be actual veins or, for fixing purposes, vegetable strings or intestines.

10 Discussion

In the above sections we have attempted a general – and not detailed – examination / description of the important parts of the skull and the neck of Josephina, a "mummy" found in the area of Palpa, Peru.

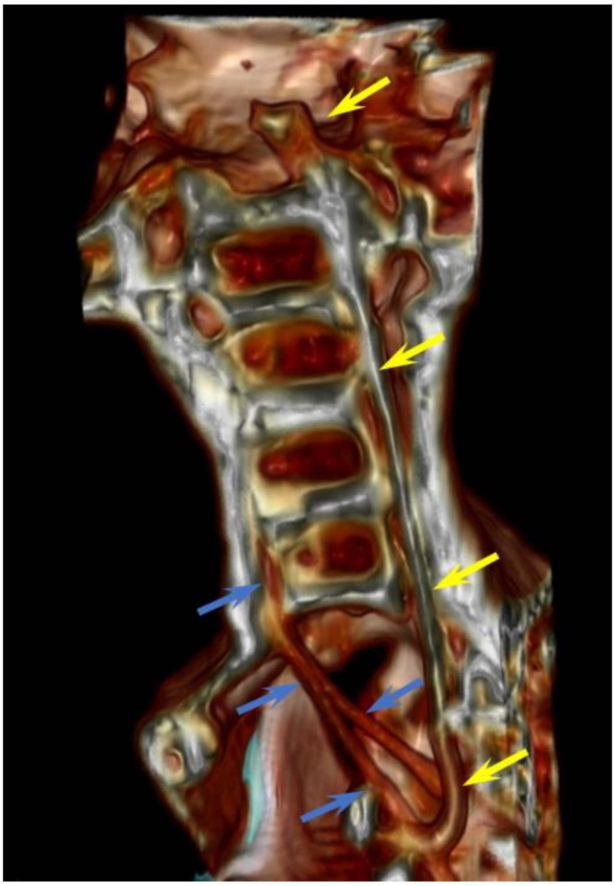


Fig. 17. Sagittal section of the neck, showing the four cervical vertebrae. The yellow arrows show the posterior cord and the blue arrows the two anterior ones.

The examination is less than complete, as many other features like openings, protrusions, etc. are present. During the process, a comparison with existing features of animals or humans was performed in order to examine if the remains belong to a leaving organism or constitute a fabrication from various parts of animals. To arrive to a definitive conclusion though, many other tests and careful examination are needed. The fact that Josephina is not the only body found, but there are many other 'bodies' available, gives the opportunity for a detailed comparison between them and a safer extraction of conclusions.

The authenticity of the finds, besides the C14 and DNA tests, can also be verified through the following proposed actions that can lead to a definite answer:

1. To CT-scan the remains with the highest resolution possible in order to distinguish small features like bone connections and cords in a sharper and clearer way. A future investigation with the highest CT-scan will verify if the mouth plates are really attached to the rest of the skull and, if not, which species they belong to. Also, the new CT-scan may determine the nature of the cords of the neck.

2. To define the elements and their percentage in the face and back head bones of Josephina by spectrometric (or other) analysis in order to verify that they form one unit. Also, to examine other body bones for comparison with the skull analysis. Of the utmost interest is the connection material between the top mouth plate and the bones of the skull. If this material is not bone, it directly points to a fabricated skeleton.

3. To define the nature of the cords that run from the head to the body by microscopic examination and spectrometric analysis.

11 Conclusion

Our examination, based on produced CT-scan images, 3D reproduction and comparison with existing literature (e.g. [13], [14], [15]), leads to the following conclusions:

(a) The "archaeological" find with an unknown form of "animal" was identified to have a head composed of a llama deteriorated braincase. The examination of the seemingly new form shows that it is made from mummified parts of unidentified animals. To this end, a new perception of the lama deteriorated braincase physiology is gained through the CT-scan examination by producing and studying various sections, as presented in the paper. This new piece of information could not have been perceived without the motivation to identify Josephina's head bones, which are most probably an archaeological find. One can point to the supposition that Peru cultures used animal body elements to express art or religious beliefs (based on the importance that llamas played in the Peruvian cosmology - see Introduction).

(b) A deteriorated lama braincase can produce features (like cavities) that can be found on a human cranium, and that also greatly resemble the main head bones of Josephina.

(c) Concerning the remains of the head of Josephina:

1. They are biological in nature. At the available resolution of the CT-scanning, no manipulation of Josephina's skull can be detected. The density of the face bones matches very well the density of the rest of the skull. No seams with glues, etc. are obvious, and the whole skull forms one unit.

2. The skull as a unit is made of thin to very thin bone, which is greatly deteriorated all over. Especially deteriorated is the lower part, which gives the impression of decomposed bone in such a scale that - in places - it cannot keep its original form without the support of the external skin. This indirectly attests to the great age of the find or to bad conditions of preservation.

3. The comparison between Josephina's skull and the braincase of a llama (and an alpaca) results mainly, in (i) differences in thickness (that may be explained by deterioration), (ii) existence of mouth plates in Josephina's skull that seem to be joined to the face bones, (iii) differences in the occipital area.

4. No similarities could be identified between Josephina's mouth plates to any skeleton part, although many parts of a skeleton may have some resemblance (modified hyoid, thyroid, vertebral piece, etc.). No remains of the feeding and breathing tracks have been identified in the present analysis. Also, the cervical vertebrae are solid, made of less dense material than bone (cartilage?) with no passage for a spinal cord. Instead, three cords have been identified connecting the head with the body.

5. There is a great similarity in shape and features between Josephina's skull and the braincase of a llama (and an alpaca). There are also features on Josephina's skull like the orbital fissure and the optic canal, similar to the llama's, that are however on the opposite site of the skull than where they should be, forcing one to accept that the skull of Josephina is a modified llama braincase.

6. One can also assume that the finds are archaeological in nature, judging from the age estimation of the metal implant present in Josephina's chest (pre-Columbian period) and the C14 chronological estimation as performed on the mummy "Victoria" (950 AD to 1250 AD). At the same time, one could assume that the remains are articulated from archaeological staff or assembled from recent biological material with the use of acids and methods that cannot be dated with C14.

7. Based on the above, if one is convinced that the finds constitute a fabrication, one has to admit at the same time that the finds are constructions of very high quality and wonder how these were produced hundreds of year ago (based on the C14 test), or even today, with primitive technology and poor means available to huaqueros, the tomb raiders of Peru.

8. The method of comparing CT-scan images of a subject to images of known material, shows its usefulness in identifying unknown bones and detecting dissimilarities.

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