A Trepanned Cranium from Tróia (Grândola, Setúbal), and the Practice of Trepanation in the Roman World

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Abstract

The collection of human remains from Tróia (Setúbal, Portugal) in the Museu Nacional de Arqueologia, Lisbon, contains the cranium of a woman exhibiting two defects characteristic of trepanation. Buried in the West Necropolis of that Roman town, the remains belonged to a woman who had undergone two craniectomies sometime during her life. The surgical procedure, known as trepanation, consisted in the extraction of one or more fragments of cranial bone from living patients. It has a long history, going back over nine thousand years, and has been reported from a number of cultures. In the Roman World it was known as a surgical procedure of great antiquity and was performed to treat various complaints, including cranial trauma, migraine and epilepsy. Evidence for its uses come from a number of written sources, Greek and Roman, dealing with medical subjects, especially bone surgery, and from the observation of lesions typical of trepanation in human remains from various archaeological sites.

Key-words: trepanation; Roman surgery; palaeopathology; Roman necropolis; Tróia (Setúbal, Portugal).

Resumo

No Museu Nacional de Arqueologia, Lisboa, encontra-se um crânio proveniente de Tróia (Grândola, Setúbal), que apresenta duas lesões características de trepanação. O crânio pertenceu a um indivíduo adulto, do sexo feminino, escavado na Necrópole Oeste daquela povoação Romana. A operação cirúrgica conhecida

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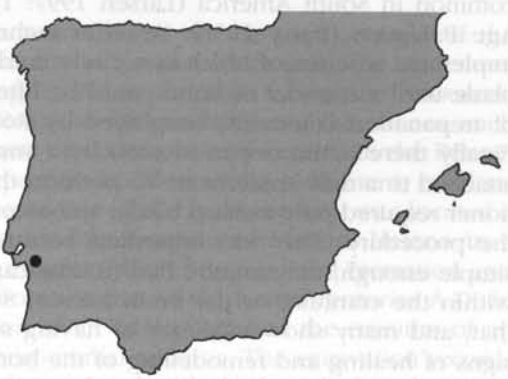
como trepanação consistia na extracção de um ou mais fragmentos de osso do crânio de pacientes vivos. Com uma longa história, a presença da prática de trepanação tem sido documentada em diversas culturas. No mundo Romano ela era conhecida como uma técnica cirúrgica de grande antiguidade, utilizada para tratar vários problemas de saúde, incluindo traumatismo craniano, enxaqueca e epilepsia. Autores, como Plínio e Galeno, referem-na nas suas obras dedicadas à ciência médica. A análise de restos humanos provenientes de locais arqueológicos, como Tróia, contribui ainda com informação indispensável para o nosso conhecimento desta prática ancestral.

Palavras-chave: trepanação; cirurgia romana; paleopatologia; necrópole romana; Tróia (Grândola, Setúbal).

1. **Introduction**

In the collection of human remains from the Roman site of Tróia (Museu Nacional de Arqueologia, Lisbon), is the cranium of a female individual displaying



two wounds possibly resulting from trepanation. Also known as trephination or trephining, trepanation is the term describing the extraction of one or more elements of cranial bone (craniectomy) from a living or recently deceased person. Although a central and northern European origin for the practice was once suggested (Piggott 1940), trepanation is now believed to have arisen independently in various areas of the world. It is a surgical practice with a long history, and has been reported from a number of world cultures (Brothwell 1994; Chege *et al.* 1996; Lisowski 1967; Oakley *et al.* 1959; Parry 1931, 1936; Sankhyan & Weber 2001; Stewart 1958; Webb 1988; Zias & Pomeranz 1992). One of the earliest examples known was found at Jericho (Palestine), and belongs to a young adult male of PPNB date (ca. 7000-6000 B.C.), with a healed trepan lesion on the right parietal (Kurth & Rohrer-Ertl 1981: 441). In some developing countries trepanation was still practised in the first half of the twentieth century (Ackerknecht 1967; Margetts 1967). The operation began with an incision to the scalp,

followed by the cutting and extraction of one or more areas of bone, the extent and depth of the incision varying with the needs of each particular case. Normally both tables of compact bone were cut resulting in the exposure of the dura, but in a few examples only the outer table of bone and diploe were removed (Ortner & Putschar 1985: 97). Different types of trepanation have been identified in archaeological materials (Buikstra & Ubelaker 1994: 160), reflecting the different methods of conducting the operation. One method consisted in the scrapping away of bone tissue gradually creating a circular wound with its edges slopping toward the centre. This technique allowed a good control of the cutting blade by the practitioner reducing the possibilities of dura mater penetration and consequent neurological damage to the patient. It is found in all areas of the world where trepanation was practised. Studies of British archaeological specimens demonstrated that the use of this method resulted in a high rate of survival to the operation (Stewart 1958). A second technique consisted in the extraction of a single section of bone by cutting out, with an implement, a delineated circular area of the cranium. This procedure, also known as circular grooving was, together with the scrapping method, one of the safest and most frequently used in Europe. A third type involved the cutting of four intersecting incisions forming a rectangle of bone that, once extracted, left a rectangular hole. With this method there was a greater risk of brain tissue damage. It was common in South America (Larsen 1997: 153), but was also practised in Iron Age Palestine (Parry 1936). Another technique involved boring with a drill implement a series of holes in a circle, and then cutting between these with a blade until a roundel of bone could be lifted. This seems to have been a form of trepanation commonly employed by Roman surgeons (Jackson 1988: 118). Finally there is the trepan created by a small hole made with a circular blade attached to a drill implement. To perform the operation successfully, the practitioner required only a sharp blade, and a certain degree of experience involving the procedure. This was important because, although the operation appears simple enough, the surgeon had to take care to avoid perforating a major vein within the cranium, or the brain tissues. Survival of the patient depended on that, and many show evidence of having survived such an operation, through signs of healing and remodelling of the bone tissue around the surgical wound (Oakley *et al.* 1959; Ortner & Putschar 1985; Stewart 1958). Another important factor would have been the technology available at the time. Different materials were used to manufacture the implements employed in the operation, and these may not have been specifically made for it. Blades made of flint, seashell and metal were employed at different periods, and some studies have been able to identify the type of tool used to perform the operation (Stevens & Wakely 1993). Trepanation could also be performed in most areas of the skull without serious danger of haemorrhage because of the little soft tissue covering the bone. However, Hippocrates[1] wrote about the dangers of operating over the

[1] Born ca. 460 BC in the Greek island of Cos, near Rhodes. In his family, the Asclepiads who traced their ancestry to the god Asklepios, medical practice was passed from one generation to the next. He learned from his father and other physicians and was head of the Coan guild of medicine. Amongst numerous other places, he practised in Cos, Athens, the Persian court of Artaxerxes, and in Thessaly where he died at Larissa in 380 BC (Jackson 1988: 19-22).

sutures because of the risk of laceration to a major vein (Lisowski 1967); the bone is also much harder and denser in these areas. Probably, these were the reasons why trepanation is normally not found located across the sutural lines (Mogle & Zias 1995: 77), although survival to the operation performed over the superior sagittal sinus has been reported (Mckinley 1992; Oakley *et al.* 1959). Even if no accidents occurred during the operation, the patient still had to struggle to overcome infection of the wound. This must have posed the greatest risk to the life of the patient. However, survival rates from archaeological specimens have been reported in excess of 50%, with some individuals having undergone more than one operation (Stewart 1958). The reasons for the practice appear diverse and not always apparent. Anthropological parallels indicate a range of factors, including the magico-religious – to release evil spirits – and a number of complaints ranging from pains to the head, especially migraine, epilepsy, and "other neurological and psychological conditions" (Waldron 2001:117). In several cases it is apparent that it was performed after an injury to remove fractured cranial bone and haematoma (Bennike 1985; Larsen 1997; Oakley *et al.* 1959; Ortner & Putschar 1985; Stewart 1958).

2. **Provenance of the specimen**

The Roman settlement of Tróia was situated on the south margin of the Sado river estuary, facing the modern city of Setúbal (Portugal). The settlement was a vast industrial site specialising in the exploitation of marine resources, especially the drying and salting of fish, and the production of fish sauces, such as *garum*. Tróia was one of the largest of such industrial centres in the Roman Empire, producing goods for the export trade. West of the settlement, overlooking a shallow lagoon formed by the waters of the Sado estuary, was located a necropolis. Excavated by a team under the direction of Manuel Heleno in a series of campaigns starting in the summer of 1948,[2] it contained cremation and inhumation burials ranging in date from the first to the fourth centuries A.D. In Grave 29 was discovered the skeleton of an adolescent and the cranium of an adult individual without associated post-cranial remains. The excavation records indicate that no artefacts were found associated with the burials, but the grave probably dates to the second/third centuries A.D.

3. **The trepanned cranium from Tróia**

The adult cranium (TR 983.451.6) from grave 29 was identified as female, on the basis of cranial morphology (Buikstra & Ubelaker 1994). Following conventional methods for age determination (Buikstra & Ubelaker 1994), it was determined that the woman had been in the middle years of her life when she died, and that she had suffered from very poor dental health, as the numerous carious lesions and abscesses affecting her dentition indicate (Fig. 1). There are

[2] The unpublished Tróia excavation diaries of Professor Manuel Heleno are kept in the archives of the Museu Nacional de Arqueologia, Lisbon.

two well-healed openings located on the back of cranium, in the left parietal (Fig. 2), forming a parallel line with the lambdoid suture, although at some distance from it. The smaller wound is circular in shape, measuring approximately 18.0 mm by 12.0 mm, and has a slightly wider margin in the endocranium. The larger wound is roughly oval in shape, with a maximum dimension of 30.5 mm anteroposteriorly by 61.0 mm mediolateraly (Fig. 3). Clear signs of complete healing are observed in the remodelling of the margins of both wounds, with smooth new bone covering the diploe. However, due to their size, the remodelling that took place around the edges of the wounds wasn't sufficient enough to completely close them. In the endocranium, reactive new bone (coarse-grained and fine-grained) can be seen covering the inner table, in the space between the two lesions. Their position and appearance seem to indicate a surgical origin – trepanation – for the wounds, and that the patient survived the operation by several years. The existence of the two wounds could also imply that the operation was performed on two separate occasions. As we have seen, serial trepanation was reported from a number of cases (Stewart 1958; Zias & Pomeranz 1992). However, what caused the operations to be made does not seem immediately apparent. On the right-hand margin of the larger trepan there are faint traces of the end of a depressed line extending into the surgical wound. Could this represent traces of a depressed fracture? Trepanation was one of the methods used by the Roman surgeon to relieve pressure on the brain following a skull fracture (Jackson 1988; Mckinley 1992). The proximity of the lesions could also indicate that they were related, with the possibility that the smaller trepan represents a second operation, perhaps performed to relieve the pressure from a blood cloth left from the first surgical intervention. This would conform to the classical sources that recommended trepanation to treat depressed cranial fractures and haematoma (Jackson 1988; Lisowski 1967). Complete healing of the surgical wounds together with partial remodelling of the bone tissue around the margins makes it difficult to diagnose with certainty the surgical method employed by the surgeon. The smaller trepan, however, could have been made with the surgical instrument the Romans called a *modiolus* (see below).

3. Roman surgery and the practice of trepanation in Roman medical literature

Literary sources tell us that the Roman surgeon performed trepanation to treat a range of conditions including headaches, epilepsy, depressed fractures and haematoma. The writings of several Roman authors make reference to the procedure. Celsus, a contemporary of Tiberius (14-37), although not a physician, wrote on the subject of medicine and medical practice. His work *De Medicina*, covers a range of medical subjects including preventive medicine, dietetics, diseases and their treatment, pharmacology and surgery. Amongst the subjects related to bone surgery, Celsus includes the practice of trepanation. When he wrote on the subject, trepanation was already a surgical procedure of great antiquity, described by Hippocrates, who recommended it to treat injuries to the head and haematoma. Trepanation was also prescribed to treat migraine. Pliny the Elder, another polymath and a contemporary of Celsus, wrote also on

a range of subjects including medicine and medical practice. In his *Historia Naturalis*, a huge encyclopaedic work in thirty-seven volumes, he refers to pains of the head that were so unbearable that could lead the patient into suicide. Migraine is attested in the medical literature from an early date (Dawson 1967: 100-1), the word itself deriving from the Greek *hemikrania* ("half-head") was borrowed from Egyptian medical practice. Trepanation was also performed to treat epilepsy but Soranus, an eminent physician from Ephesus who worked in Rome during the Principate of Trajan (98-117) and of Hadrian (117-138), recommended against it. A combination of factors – deficient knowledge of anatomy and of anaesthetics; the high risk of septicaemia – contributed to make surgery one of the last options to be considered by the physician. Attempts were always made to treat disease with a range of measures that included exercise, diet, drugs, and blood letting. Hippocrates even advised physicians against the treatment of terminal cases in case they were blamed for the death of the patient. In spite of this, surgery was often the last option left to the patient.

Celsus writes about the operation to remove injured cranial bone. He recommends it only as a last resort, cautioning the practitioner to employ extreme care in the cutting and removal of bone so as not to damage the cerebral membrane. Writing about the qualities of an ideal surgeon, he says: "A surgeon should be young...nearer youth than age; with a strong and steady hand which never trembles..., with vision sharp and clear, and spirit undaunted; filled with pity so that he wishes to cure his patient yet he is not moved by his cries, to go too fast, or cut less than is necessary; but he does everything just as if the cries of pain cause him no emotion."[3]

Without efficient anaesthetics pain would have been a major problem during and after surgery. In trepanation, the patient would have felt it especially during the incision and lifting of the soft tissues covering the cranial bone. The actual cutting of the bone would have also caused some discomfort but was less painful, and has been described by one author as probably not worse "than the torture occasionally inflicted on us by the dentist" (Freeman 1918: 445). To alleviate the pain, the surgeon could administer the patient a drink of alcohol, or made with herbal ingredients such as opium, henbane or mandrake.[4] Opium and henbane were known to have efficient qualities as sedatives. Pliny recommended the drink of white mandrake root to induce sleep, and as an anaesthetic administered before an operation and sutures. Celsus also wrote on the properties that the juice of wild poppy had to alleviate pain. For example, the drug known as *theriac*, prescribed by Galen[5] to the Emperor Marcus Aurelius (161--180) to alleviate his chest pains, contained opium amongst its active ingredients (Jackson 1988, 170). This was extracted from the cultivated poppy (*Papaver somniferum*), which produced a stronger kind of opium than its wild relative. It

[3] Celsus, *De Medicina VII Prooemium 4.* In Jackson 1988, p. 112.

[4] The medical uses of certain plants were well known. Pedanius Dioscorides, a physician native of Anazarbus in Cilicia, wrote around 64 AD a famous work on pharmacology, *De Materia Medica*, describing the medicinal properties of plants.

[5] Born in 129 in Pergamon, he studied medicine at Smyrna, Corinth and Alexandria. In 169 he was apointed court physician to the co-emperors Marcus Aurelius and Lucius Verus. Twenty-one volumes of his work on medicine still survive. He died around the year 210 (Nutton 1973; Jackson 1988: 60-65).

was also highly addictive, and both Galen and Marcus Aurelius were conscious of it. Pliny and Galen also recommended the juice extracted from the seeds of *Cannabis sativa* as analgesic.

Once measures were taken to sedate the patient, the surgeon could proceed with the operation. In a comfortable position, in a well-lit place, and with the help of an assistant, he would have first delineated the extent of the area of bone to be removed and, with that in mind, proceeded to cut into the scalp of the patient. The x-shaped cut was probably done with a scalpel of a type similar to those found at Conimbriga (Alarcão 1994: 43, 127-8), Herculaneum and Pompeii (Jackson 1986). The surgeon's *instrumentarium*, would have included a range of precision instruments that were stored and transported in wooden cases. The *instrumentarium* from Torre d'Ares[6] (Tavira, Portugal), consisting of four tweezers, seven probes, five spoons and one large decorated spatula, is typical of the type of instruments employed by the Roman medical practitioner. In the Museu Monográfico de Conimbriga (Condeixa, Portugal), there are also particularly good examples of bronze scalpels, originally with blades made of iron for greater cutting precision. Present are also bronze dissectors, with fine hooked extremities, employed to retract folds of skin and muscle (Alarcão 1994: 127-8).

The cut into the scalp of the patient would have caused some bleeding, but experience would have told the surgeon that by folding back the cut flaps of soft tissue, haemorrhage could be considerably reduced. The outer cranial bone was thus exposed. In a large operation, Celsus recommended drilling a circle of holes with a bow, or a strap-drill, and then cutting between these with a sharp chisel blade. For small trephines the *modiolus*, a drill with a rotating cylindrical blade, was recommended. He explains: "The *modiolus* is a hollow cylindrical iron instrument with its lower edges serrated; in the middle of which is a fixed pin...a small pit is made with the angle of a chisel for the reception of the pin, so that, the pin being fixed, the modiolus when rotated cannot slip; it is then rotated...by means of a strap. The pressure must be such that it both bores and rotates; for if pressed lightly it makes little advance, if heavily does not rotate...When a way has been cut by the *modiolus* the central pin is taken out, and the *modiolus* worked by itself."[7] Two examples of this type of surgical tool were discovered in a grave at Bingen (Mainz, Germany), dated to the late 1st or early 2nd centuries AD (Jackson 1988: 118). It was still used in Europe during the 18th century to perform trepanation. During the course of the operation, the surgeon had to be careful not to cut too deep or he risked injuring a major vein, or the membrane covering the brain. The operation resulted in a large section of loosened bone that was lifted for extraction. If successful, the greatest danger facing the convalescing patient would be the possibility of infection to the surgical wound. Septicaemia was a major problem. Powerful antiseptics weren't used but certain substances with mild antiseptic properties were known. Celsus was aware of the antiseptic properties of turpentine and pitch, and he advised on the proper cleaning of wounds and instruments. Wine, vinegar, resins and metallic compounds were also used to treat wounds. Several

[6] Museu Nacional de Arqueologia, Lisbon.

[7] Celcus, *De Medicina VIII, 3.* In Jackson 1988, p. 117.

medicines also contained copper, lead, zinc, iron, or combinations of these, and would have contributed to stop haemorrhage and treat the wound. These would have been mixed, with a spatula, on a small stone palette held in the hand of the surgeon or his assistant. The collection of surgical instruments from Torre d'Ares, mentioned above, contains a fine example of one such stone palette.[8] It has been suggested that osteitis and scarring of the bone tissue observed in some trepanned specimens resulted from the use of such remedies containing chemical irritants applied to the wound after the operation. However, the bone reaction in these cases was more likely the result of sepsis of the wound (Stewart 1958). Once the operation was completed, the flaps of skin were returned to their original position and allowed to granulate. In the case of larger surgical cuts, the wounds were often sutured with needle and thread[9] and covered with a bandage. In book five of *De Medicina*, Celsus recommends bandages made of linen, wide enough to cover the wound in a single turn; more turns being necessary in winter than in summer (Jackson 1988: 126-8).

4. Conclusion

Trepanation was a surgical procedure of great antiquity by the time it was performed on a woman from the Roman settlement of Tróia. The subject had been operated to remove elements of cranial bone from her left parietal, leaving two trepan holes of different size in the back of her head. The medical writings of Greek and Roman authors refer to the practice of trepanation providing clues to the reasons for its use. In this particular case it is difficult to attribute with certainty the reasons that caused the operations to be made. The possibility that they were performed to remove injured cranial bone seems plausible, with interventions on two separate occasions. A first operation soon after a depressed fracture to the back of the head, and a second sometime later. Observation of the lesions indicates that the woman survived long after the operations. The process of healing resulted in bone remodelling of the wounds making it difficult to determine the precise surgical method employed by the surgeon. This case is of special interest, providing direct evidence of the successful performance of trepanation in Roman Lusitania, and attesting the type of medical care available to the inhabitants of this province. However, in this particular case, one must also consider the possibility that the operation may have been performed elsewhere and that, at a later stage in her life, the woman moved to Tróia where she eventually died and was buried.

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[8] Museu Nacional de Arqueologia, Lisbon.
[9] Clesus *De Medicina VIII*, 16. Ibid., p. 126-7.

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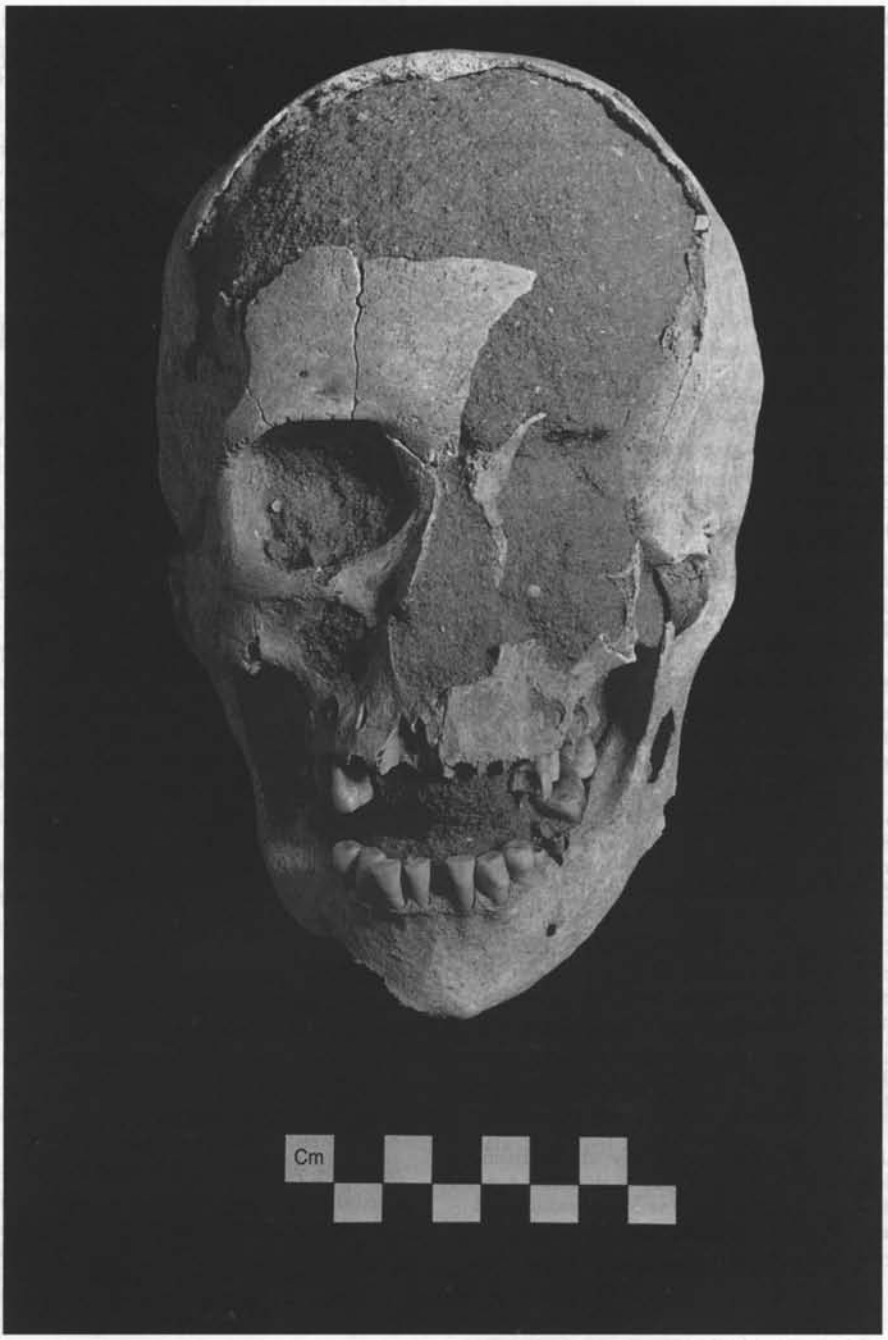

Figure 1 – The female adult cranium (TR 983.451.6) from Grave 29, West Necropolis, Tróia (Grandola, Setubal). Museu Nacional de Arqueologia, Lisbon.
(Photograph: José Paulo Ruas).

Figure 2 – Posterior view of the cranium from Tróia (TR 983.451.6), showing position of the two trepanation wounds. Museu Nacional de Arqueologia, Lisbon.
(Phototograph: José Paulo Ruas).

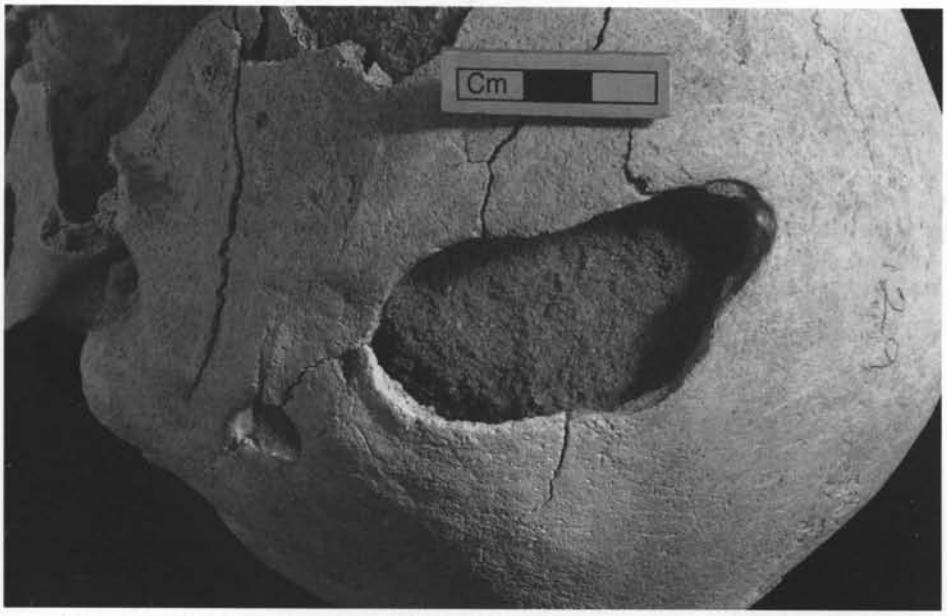

Figure 3 – Detail view of the lesions. Museu Nacional de Arqueologia, Lisbon. (Photograph: José Paulo Ruas).