# REPLICATION OF CRANIAL GUNSHOT WOUNDS

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## ABSTRACT

It is possible to differentiate between entrance and exit wounds in bone by examining the specimen concerned. Because of the evidential usefulness of providing jurists or members of a jury with such specimens, we describe an easy and reliable method for replicating gunshot wounds in the human skull utilizing dental materials and methods.

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**Key words:** Gunshot wounds, ballistics

## INTRODUCTION

Terminal ballistics is the study of the motion and penetration of a moving projectile when it comes in contact with the body.[1] The amount of tissue damage typically is determined by the efficiency of energy transfer, which in turn is dependent on the physical characteristics of the projectile, its deformation and fragmentation, kinetic energy, entrance profile and path traveled through the body.[2] It has been claimed that the direction in which a bullet was travelling may be determined by the appearance of the wound in bone.[3] Typically the entrance is round to oval with a sharp, punched out appearance, while the exit would is large, irregular and beveled. A number of cases of beveling of the entrance wound have been reported[4] but the mechanism of external beveling is not well understood.

Given the evidential value of physical examination and preservation of gunshot wounds in dry bones, we report on a simple and accurate replication method for which no specialized equipment is required.

## SPECIMENS AND METHODS

Two human calvaria (that part of the skull after the facial bones have been removed), each with a single gunshot wound, were replicated. The first specimen had an execution type entry wound at the occiput (Fig.1) with a classic internal bevel (Fig.2). The second had an entry wound on the inner surface of the occipital bone (Fig.3) with a beveled edge on the outer bony plate (Fig.4).

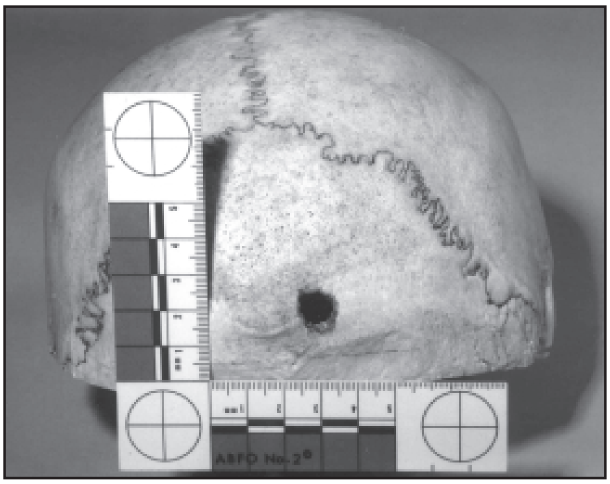


***Fig.1:*** *Outer table entrance wound in a human occipital bone*

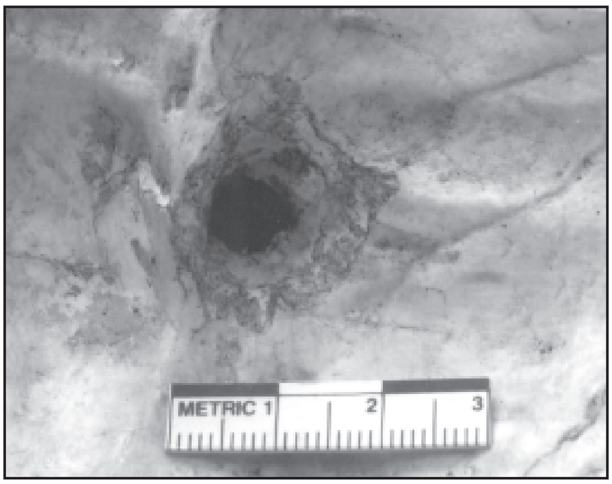


***Fig.2:*** *Exit site with inner table bevelling*

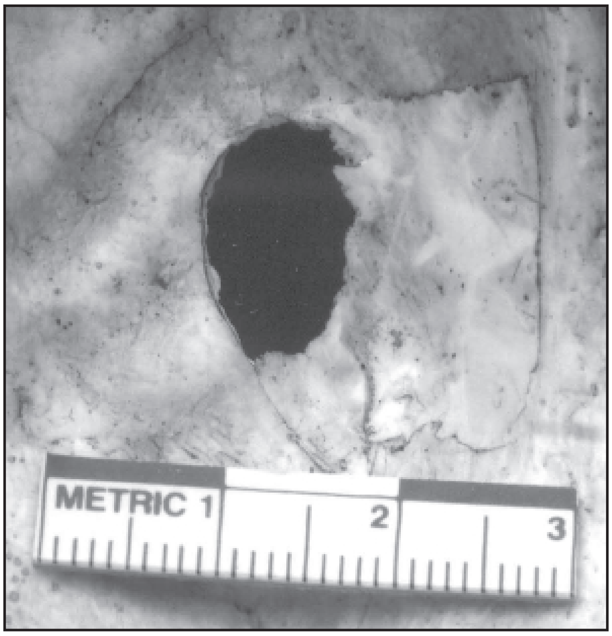


**Fig.3:** *Inner table entrance wound with a sharp, punched out appearance*

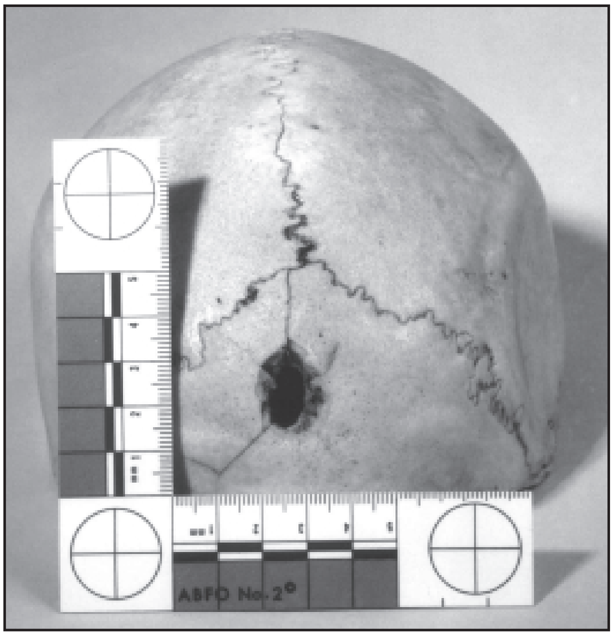


**Fig.4:** *Outer table exit wound with characteristic bevelling*

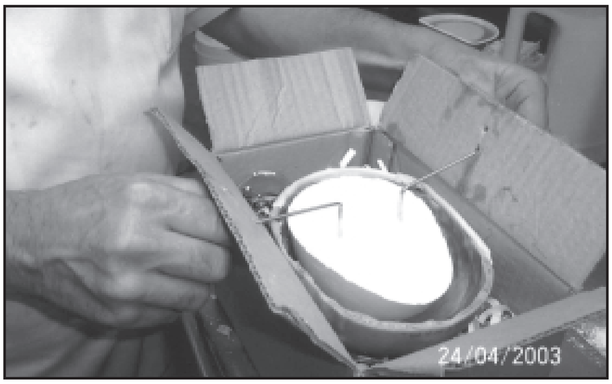


**Fig.5:** *Plaster plug acting as a space maintainer for the inner impression of the calotte*

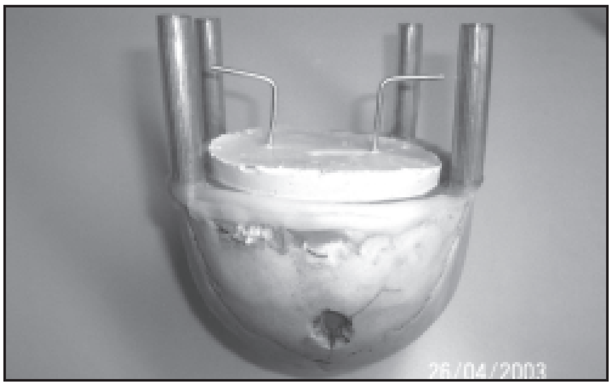

**Fig.6:** *Plaster plug, calotte with tubes and dowels*

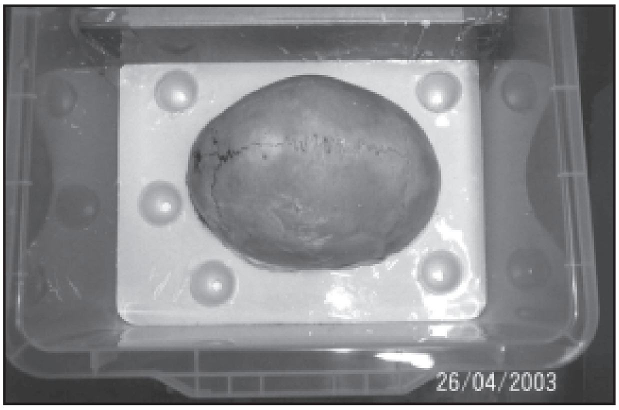


**Fig.7:** *Plastic container, dental stone base and calotte positioned for outer impression*

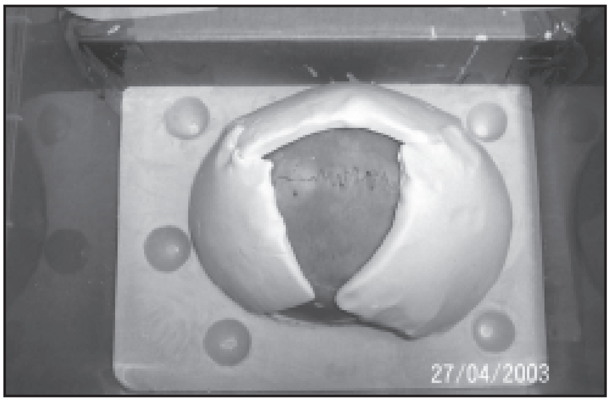


**Fig.8:** *Modelling clay being overlaid to provide space for silicone impression of outer surface of the calotte*

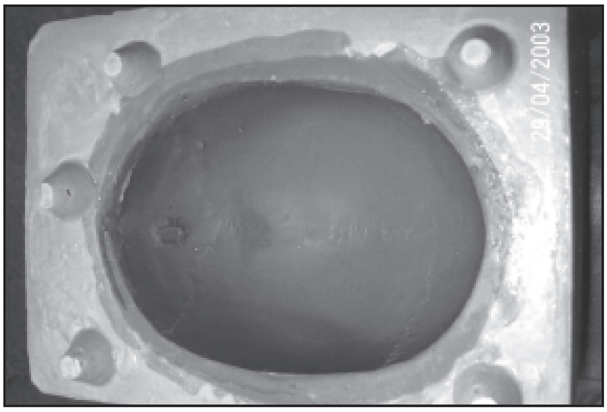


***Fig.9:*** *Casting complete after separation of stone moulds*

***Fig. 10****: Compression of actual calotte with casting, right*

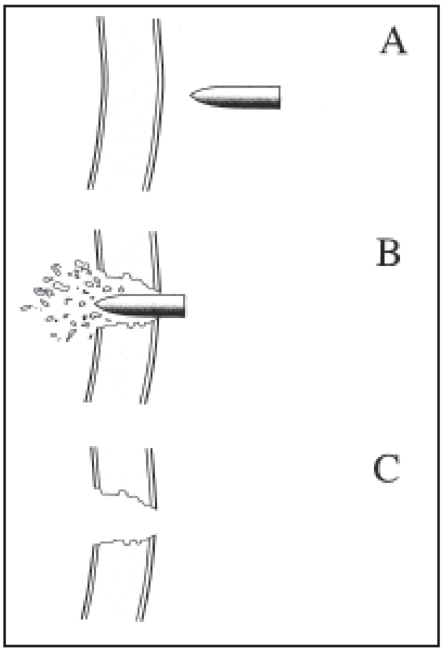


***Fig. 11:*** *Bullet perforating cranial bone leaving a sharp, punched out entrance and bevelled exit wound*

An impression of the inner surface of the skull was produced by first constructing a plaster plug as a space maintainer. The plug was then held in position while room temperature vulcanising silicone* was poured and allowed to cure (Fig.5). Once this inner replication of the skull was made, four dowel rods with plastic tubings were secured to the base of the calotte. The dowel rods would eventually be removed and the tubings would become pouring vents for the casting material (Fig.6). A plastic container was used to hold dental stone poured to the level of the base of the specimen (Fig.7). This held the plug in position and provided one half of the casting mould.

Next we made an impression of the outer surface of the skull. A 10mm layer of modelling clay was laid over the skull, to provide space for the silicone (Fig.8). A separator was applied to the first stone pour, over the modelling clay, and a second stone pour cast. When set the mould was separated, the modelling clay removed and separator applied to both moulds (Fig. 9). The moulds were then reassembled and silicone was poured and allowed to cure. The moulds were separated and the skull fragment removed. The dowel rods were also removed, leaving the plastic tubes *in situ*. After the moulds were reassembled, the casting material was poured into the mould. Once cured, the two halves of the mould were separated and the cast divested, vents and flash removed and the replica finished (Fig. 10). This procedure allowed a number of casts to be produced from the same mould.

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* *®Ultrasil, Barnes, Bankstown NSW Australia*

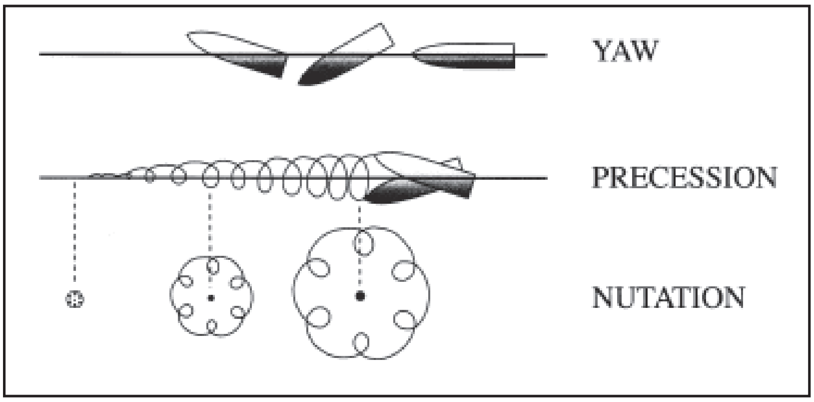


***Fig. 12:*** *Complex three dimensional movements of a projectile in flight (after Bartlett, 2003 [2])*

## DISCUSSION

When a projectile perforates bone, it creates a bevel in the direction in which it is travelling[3] (Fig.11). The degree of damage is dependent on the amount of kinetic energy lost by the projectile as it hits the bone.[5] Factors that influence the kinetic energy include the mass and calibre of the bullet as well as deviations from the flight path[6]. Briefly, the inertia of a projectile acts on its centre of mass while retarding forces act in front of the centre of mass, in the nose of the bullet. This will result in a slight deviation along the long axis of the projectile, known as yaw[7] (Fig.12). Because non-spinning bullets are unstable, gyroscopic stability has to be achieved by barrel rifling.[8] Spin, together with yaw, results in a movement called precession which, once the projectile leaves the barrel compounds into a complex motion in a rosette pattern, called nutation[6]. Both precession and nutation increase after the bullet strikes the bone and increases the wound capacity of the projectile.

Differentiation of entrance from exit wounds in bone is possible with examination of the specimen concerned. The entrance wound is cone-shaped and the exit wound beveled.[3] We present here an easy and accurate method by which such wounds may be replicated for the use of evidence or in the teaching of forensic science.

## ACKNOWLEDGEMENTS

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