**Letter to the Editor**
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# Cranial Keyhole Defect from a Perpendicular (Non-tangential) Bullet Strike - A Paradox of Medicolegal Relevance

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## Letter to the Editor

### Dear Editor

A scrutinized observation of the firearm injury reported by Sirohiwal BL, et al. [1] reveals certain noteworthy facts that may be of considerable relevance to the working forensic pathologists and anthropologists, as follow:

- The entrance and exit wounds over the head are placed almost diametrically opposite, i.e., over the right and left temple regions, respectively. Thereby, it is evident that the bullet has taken an almost straight and perpendicular path within cranium (after excluding internal ricochet/contour shot/bullet fragmentation from the described bullet track and intracranial findings).
- The right squamosal temporal region of skull beneath entrance wound shows a typical keyhole-lesion (K-L herein after), comprising of a superior round component with internal beveling and an inferior wedge-shaped component with slight external beveling at its lower end. Additional features typical of a K-L are evident from the location and course of linear fractures radiating from the defect's margins.

As such, the unique morphology of an evident K-L skipped appreciation in the original case report [1].

A finding that in-particular draws our attention to the case is that the K-L is located in the path of a perforating gunshot injury, i.e., the bullet struck the cranium perpendicularly and thereby non-tangentially [1], while in forensic literature the cranial K-L has been classically related to a tangential and relatively superficial bullet strike (where the projectile and/or its fragment thereof enters and exits from the same location over the skull, respectively) [2-5].

Therefore, the finding calls an explanation regarding atypical mode of formation of K-L in this case [1]. In this context, a couple of forensic case studies have highlighted the formation of K-L from a non-tangential bullet strike.

Delannoy Y, et al. [6] described the formation of K-L from a perpendicular shot to the cranium. In their case study, the entrance wound over right temporal skull region depicted typical K-L as a part of perpendicular bullet track. An incomplete exit wound was present over contra-lateral temporal region. The authors verified their observation experimentally by shooting 12 human cadaveric crania in a perpendicular plane and succeeded in producing K-L (of interest) in one of the skull [6].

Coincidently, the K-L in both of the cases [1,6] matched topographically and morphologically, including range, location and course of firearm injury.

Berryman HE and Gunther WM [8], in their case of gunshot-related K-L in humerus bone, hypothesized that the secondary fractures radiating from bullet's impact point are circumscribed by arc-like (tertiary) concentric fractures located away from the bullet's impact point and placed perpendicular to the radial fracture lines. The fracture complex, thereby, takes the form of typical K-L. Their hypothesis was further confirmed by microCT analysis of an experimental shot associated with K-L (in perpendicular path) in the study of Delannoy Y, et al. [6].

Mittal P [7] described the case of a homicidal gunshot injury where an FMJ bullet perforated the cranio-cerebrum straight and non-tangentially from left parietal to sphenoid region. The injury caused formation of a K-L at the entrance site (over parietal bone). A bisected and hinged bone plug was shown in-situ, suggesting involvement of fracture-web mechanism (primary impact-secondary-tertiary) in the formation of K-L. The bullet was found intact at recovery [7]. The finding confirmed the previous hypotheses [6,8].

The formation of K-L from a non-tangential shot appears to be a rather rare phenomenon which is also evidenced by its experimental reproduction in (merely) one out of twelve crania that were shot perpendicularly in the study [6]. The interplay of the multitude of elements involved in fracture production, comprising of extrinsic and intrinsic factors and the fracture-characteristics (fracture assessment triad), may be held responsible for such variations [9]. The phenomenon seems to be predominantly associated with FMJ bullets, as evident from the cases reported so far [6,7].

In conclusion, it may be said that the formation of cranial K-L in a perpendicular bullet path, as highlighted by the case of Sirohiwal BL, et al. [1], suggests its formation independent of angle of bullet strike, supported additionally by Delannoy Y, et al. [6] and Mittal P [7] thereby refuting its strict adherence to the traditionally explained tangential bullet impacts [2-5]. The case study [1] sets yet another example of keyhole formation from a non-tangential gunshot injury [6,7].

The proposed alternative mechanism may help in reconstructing the case circumstances, esp. in discrepant situations anticipating confirmation of shot direction as well as the nature of bullet trajectory within the body.

## Conflicts of Interest

The author declares that there are no possible conflicts of interest.

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