COLOUR ATLAS OF FORENSIC TRAUMATOLOGY

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Version 1

Firearm Injuries

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FOREWORD

The greatest pleasure I experience as a teacher, is to see my students excel in their chosen careers and perform even better than myself. The series of e-booklets prepared to better equip medical officers to handle common conditions likely to be encountered in their day to day forensic practice by Professor Dinesh Fernando, is a good example of one of my students doing better than me!

Dinesh is the son of Emeritus Professor of Community Medicine, Former Head, Department of Community Medicine, Former Dean, Faculty of Medicine and Vice Chancellor of the University of Peradeniya, Malcolm Fernando, who was an illustrious medical academic. Following his father's footsteps, he joined the University of Peradeniya in 2003.

Dinesh was one of my post graduate trainees at the Department of Forensic Medicine and Toxicology, Faculty of Medicine, Colombo, and obtained the doctorate in Forensic Medicine in 2003. He underwent post-doctoral training at the Victorian Institute of Forensic Medicine, Melbourne, Australia, with my colleague and contemporary at Guy's Hospital Medical School, University of London, Professor Stephen Cordner. During this period, he served as the honorary forensic pathologist of the Disaster Victim Identification team in Phuket, Thailand following the tsunami, and was awarded an operations medal by the Australian Federal Police.

He has edited, and contributed chapters to, 'Lecture Notes in Forensic Medicine' authored by the former Chief Judicial Medical Officer, Colombo, Dr. L.B.L. de Alwis and contributed to 'Notes on Forensic Medicine and Medical Law' by Dr. Hemamal Jayawardena. He is the editor of the Sri Lanka Journal of Forensic Medicine, Science and Law. Continuing his writing capabilities, he has compiled an important and unique set of e-booklets which will be a great asset to undergraduate and post-graduate students of Forensic Medicine, and also to our colleagues. Its succinct descriptions of complicated medico-legal issues and clear and educational photographs are excellent. It makes it easy for the students to assimilate the theoretical knowledge of each topic as they have been augmented with histories, examination findings, macroscopic and microscopic photographs of actual cases. In some areas, photographs from multiple cases have been included, so that the students can better appreciate the subtle differences that would be encountered in their practice.

I sincerely thank my ever so grateful student Dinesh, for giving me this great honour and privilege to write the foreword.

Professor Ravindra Fernando

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FRCP (Glasgow), FRCP (Edinburgh), FRCPath. (UK)

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About the authors.....

Dr. Dinesh Fernando is a Senior Professor in Forensic Medicine at the Faculty of Medicine, University of Peradeniya and honorary Judicial Medical Officer, Teaching Hospital Peradeniya. He obtained his MBBS in 1994 with Second class honours from the North Colombo Medical College, Sri Lanka, and was board certified as a specialist in Forensic Medicine in 2004. He obtained the postgraduate Diploma in Medical Jurisprudence in Pathology from London in 2005, and possesses a certificate of eligibility for specialist registration by the General Medical Council, UK. He underwent post-doctoral training at the Victorian Institute of Forensic Medicine, Melbourne, Australia. He has also worked at the Wellington hospital, New Zealand, as a locum Forensic Pathologist and as an Honorary Clinical Senior Lecturer at the Wellington School of Medicine and Health Sciences, University of Otago, New Zealand. He was invited to visit and share experiences by the Netherlands Forensic Institute in 2019. He was conferred a Fellowship by the College of Forensic Pathologists of Sri Lanka in 2021.

Dr. Sarangi Amarakoon was a temporary research assistant at the Department of Forensic Medicine. She obtained her MBBS in 2023 with second class honours from the Faculty of Medicine, University of Peradeniya and Dr. Diniki Agalawatte was a temporary lecturer at the Department of Forensic Medicine. She obtained her MBBS in 2025 with second class honours from the Faculty of Medicine, University of Peradeniya. Dr. Shanika Ekanayake is a temporary lecturer at the Department of Forensic Medicine. She obtained her MBBS in 2025 with second class honours from the Faculty of Medicine, University of Sri Jayewardhanapura. The authors gratefully acknowledge Prof. Sarathchandra Kodikara, Dr. Kasun Ekanayake, Dr. Manjula Peiris and Dr. Patalie Delgahagoda for providing the case history and photographs of the second, third and fourth and fifth cases of trap gun injuries, respectively.

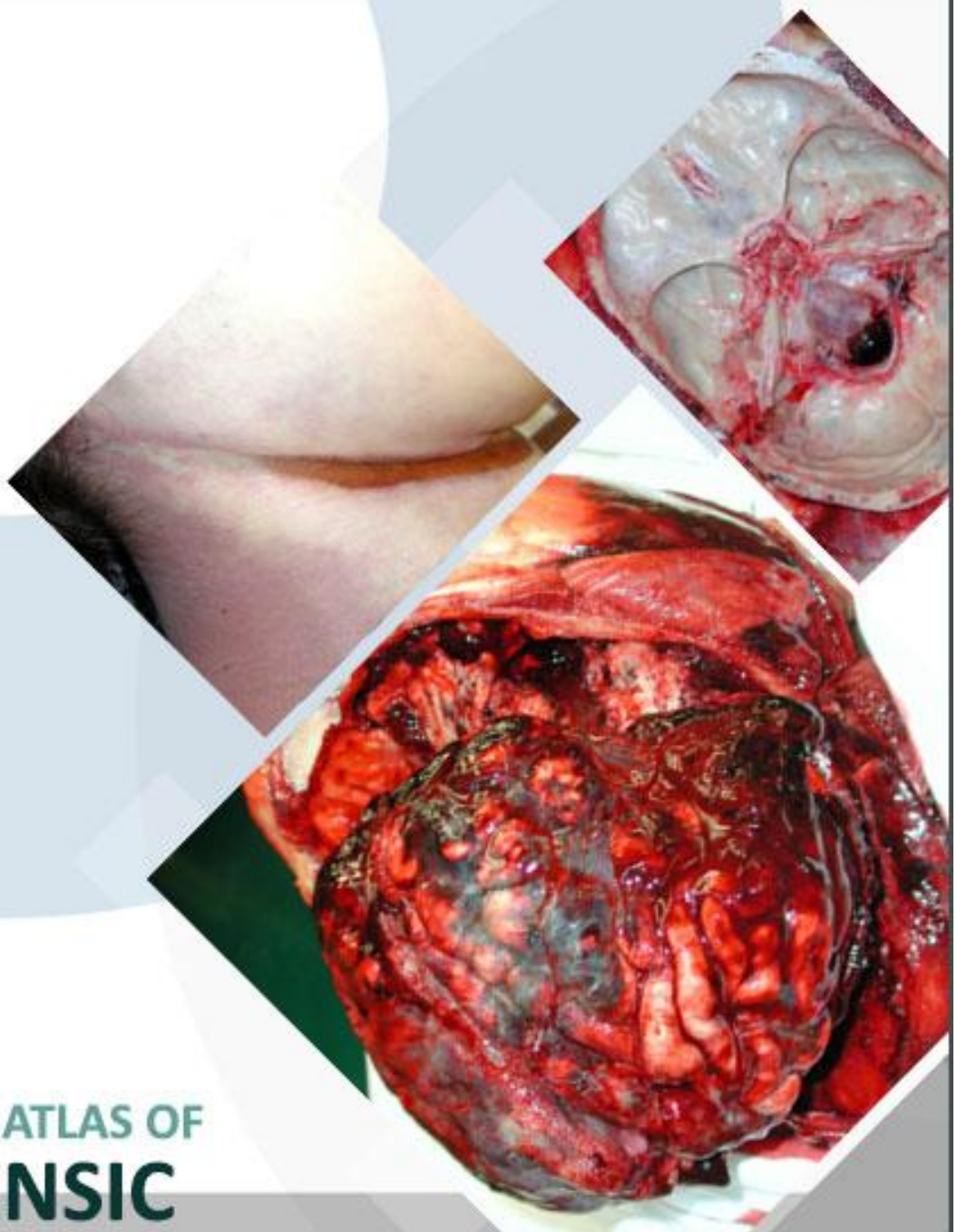
PREFACE

Forensic Medicine in Sri Lanka encompasses, both, examination of patients for medico-legal purposes and conducting autopsies in all unnatural deaths, in addition to those that the cause of death is not known. In the eyes of the justice system in Sri Lanka, all MBBS qualified medical officers are deemed to be competent to conduct, report and give evidence on medico-legal examinations of patients and autopsies conducted by them, as an expert witness. However, during their undergraduate training, they may not get the opportunity to assist, nor observe, a sufficient variety of representative of cases that may be encountered in the future.

Therefore, a series of e-booklets has been prepared to better equip medical officers to handle common conditions that are likely to be encountered in day to day forensic practice. The case histories, macro and micro images are from cases conducted by Prof. Dinesh Fernando. Ms. Chaya Wickramarathne did a yeomen service in the initial designing of lay out and formatting the booklet. The compilation of the case and photographs for publication was initiated by Dr. Sarangi Amarakoon, continued by Dr. Diniki Agalawatte and finalized by Dr. Shanika Ekanayake.

The content herein may be used for academic purposes with due credit given.

Any clarifications, suggestions, comments or corrections are welcome



COLOUR ATLAS OF

FORENSIC TRAUMATOLOGY

ILLUSTRATIVE CASES

Firearm Injuries

History

A 42-year-old male builder, with a history of antidepressant use, financial and marital issues, was found dead lying across the rear seat of his 4-wheel drive vehicle with his head behind the driver's seat. A "Ramset" nail gun, wrapped in a piece of cloth, was in his right hand. The body was in a state of rigor. There was dried blood on the forehead and on the hands of the deceased. A straight metal nail and a paperback "Sudoku" book with a small hole were recovered from the vehicle. On the back of the book, there was a roughly circular hole, which measured approximately 8 mm in diameter, surrounded by a circular indentation, 20 mm in diameter. On the front of the book, there was a circular hole measuring approximately 7 mm in diameter with eversion of the margins. Blood staining was present around the hole and on the corners of the book.

The muzzle of the Ramset nail gun found at the scene had a diameter of 20 mm, and the imprint matched that on the back cover of the Sudoku book. The trigger was curved, 30 mm in length, and had a width of 6 mm. Fragments of what appeared to be bone were present at the muzzle end of the gun. A discharged 0.22 cartridge was in the chamber. The nail retrieved from the vehicle was silver in colour, 75 mm long, and 3 mm in diameter. The head was round and had a diameter of 7 mm.

External examination

Black grease/ grime-like material was present under the fingernails and on the palmar aspect of the fingers. A groove-like depression was present on the palmar aspect of the distal phalanx of the right thumb. It was transversely placed and measured 3 cm in length and 10 mm in width. No injuries or blackening was seen on either hand.

1. An irregularly circular perforating laceration of the scalp with irregular margins, 8 mm in diameter, was seen on the forehead, 10 mm to the right of the midline and 40 mm above the glabella, and there were seven superficial micro lacerations radiating outward from the medial and superior margins of the defect. No burning, blackening or tattooing was present surrounding the injury. Marginal bruising was present.

2. A cruciate laceration measuring 6 x 3 mm was seen on the posterior aspect of the scalp. The midpoint was located 10 mm to the right of the midline and at the horizontal level of the roots of the ears. No burning, blackening or tattooing was present.

Internal examination

Musculoskeletal System: Circular deficiencies of the frontal and occipital bones were identified corresponding to the injuries on the scalp. Underlying external injury No.1 was a circular deficiency of the frontal bone which measured 8 mm in diameter. A linear fracture measuring 4 mm in length extended to the right. Internal beveling was present and had a maximum diameter of 15 mm.

Underlying external injury No. 2 was a roughly oval deficiency on the occipital bone just to the right of the midline which measured 8 x 5 mm. Surrounding this was an area of external beveling with a maximum diameter of 25 mm.

Stripping the dura from the skull and calvarium revealed bilateral anterior and middle cranial fossa fractures and a linear fracture extending into the right posterior cranial fossa.

Central Nervous System: The brain was softened and lacerated. A tract extended through the right frontal lobe and exited through the right temporal lobe close to the brainstem. The brain in relation to the tract was contused and lacerated. A thin subarachnoid haemorrhage was present over the hemispheres. Multiple cross sections of the cerebral hemispheres revealed laceration of the right cerebral hemisphere in relation to the tract of the missile. The left cerebral hemisphere was free of contusion or laceration. Streaky haemorrhages were present in the right midbrain and pons.

Microscopic examination

The sections taken from the right frontal lobe showed bone fragments and birefringent foreign material within the substance of the brain. Sections taken from the midbrain and pons showed multiple foci of haemorrhage. No other significant abnormality was seen.

Investigations

43mg/100ml of alcohol and 0.09 mg/L of methamphetamine were detected in blood taken at the time of autopsy.

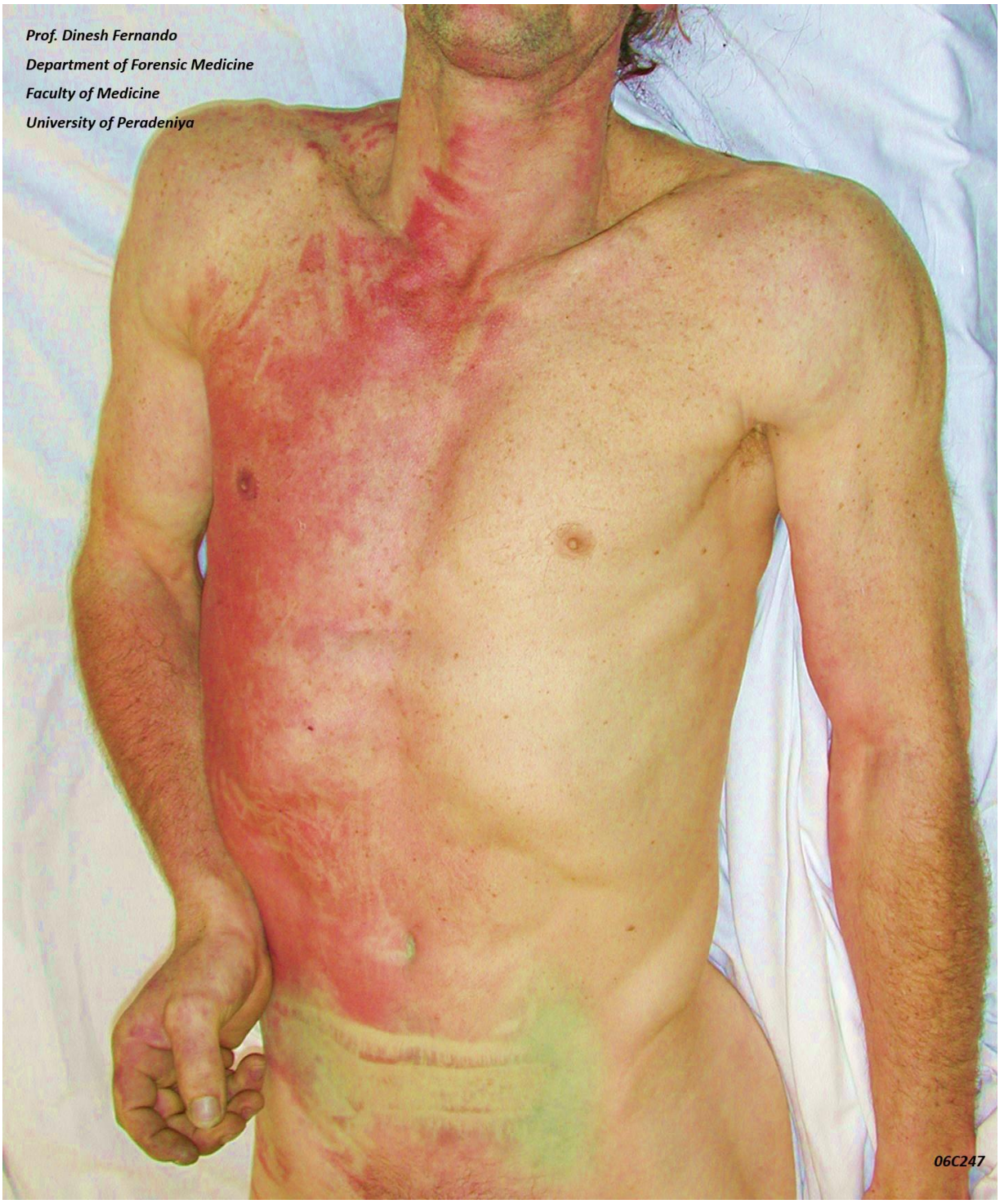


Figure 1: The deceased with right sided fixed hypostasis of the chest, abdomen, right forearm, hand with sparing of right side and beneath the waistband. In addition there is a greenish discolouration of bilateral iliac fossae. Note the right wrist in rigor mortis in the extended position.

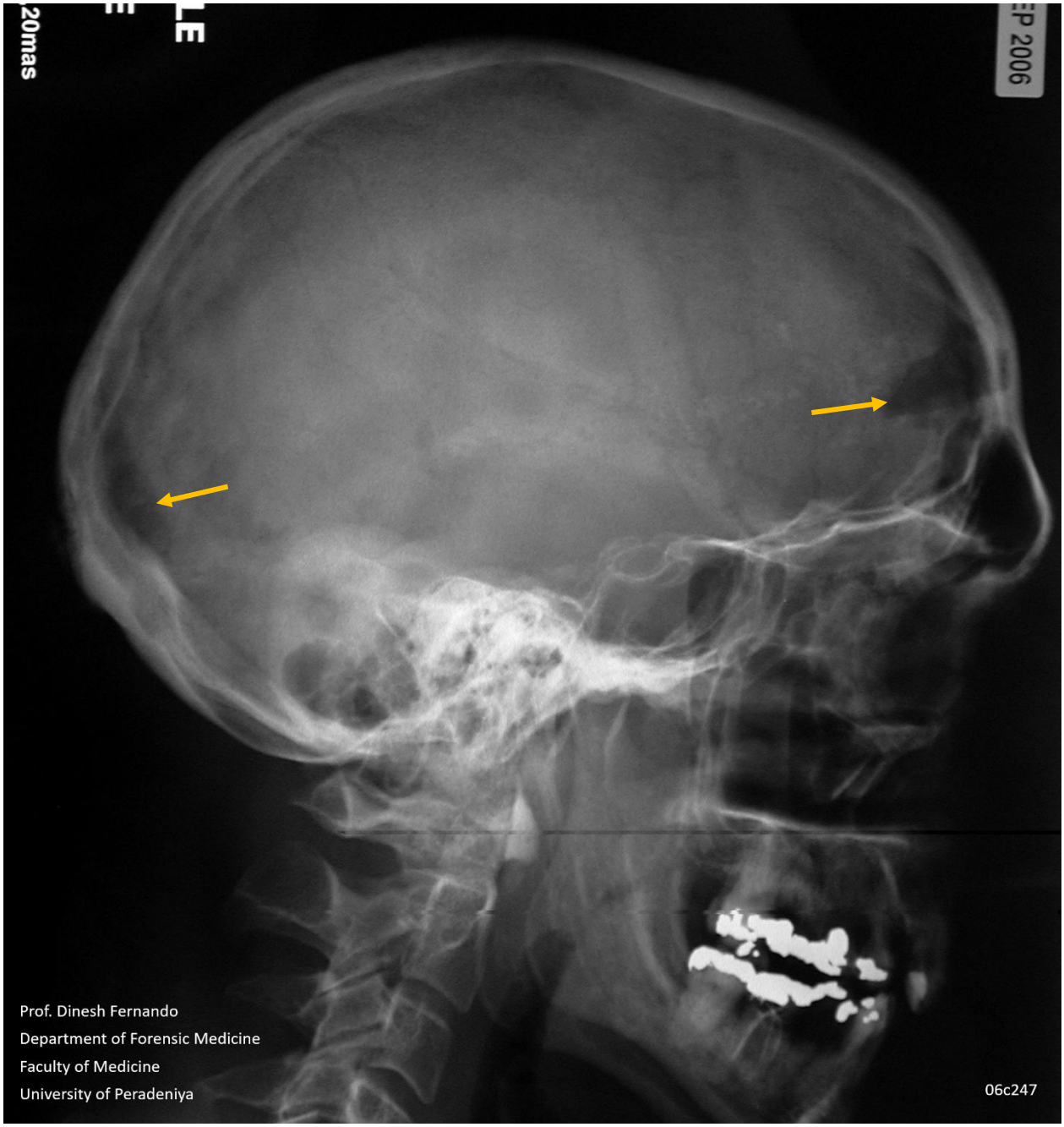


Figure 2: Lateral X –ray of skull showing the entry wound in the frontal region and exit in the occipital bone. (Arrows)

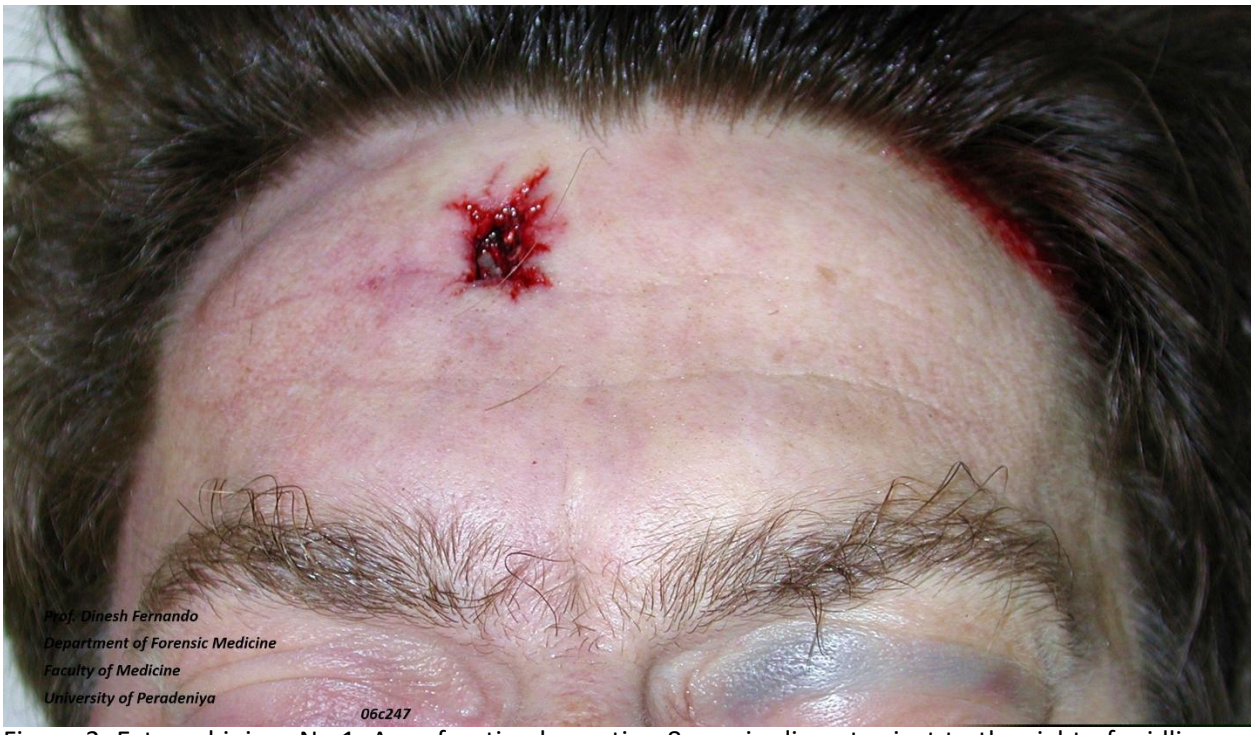


Figure 3: External injury No.1. A perforating laceration 8 mm in diameter just to the right of midline on the forehead. Note the supraorbital haematoma on the left side.

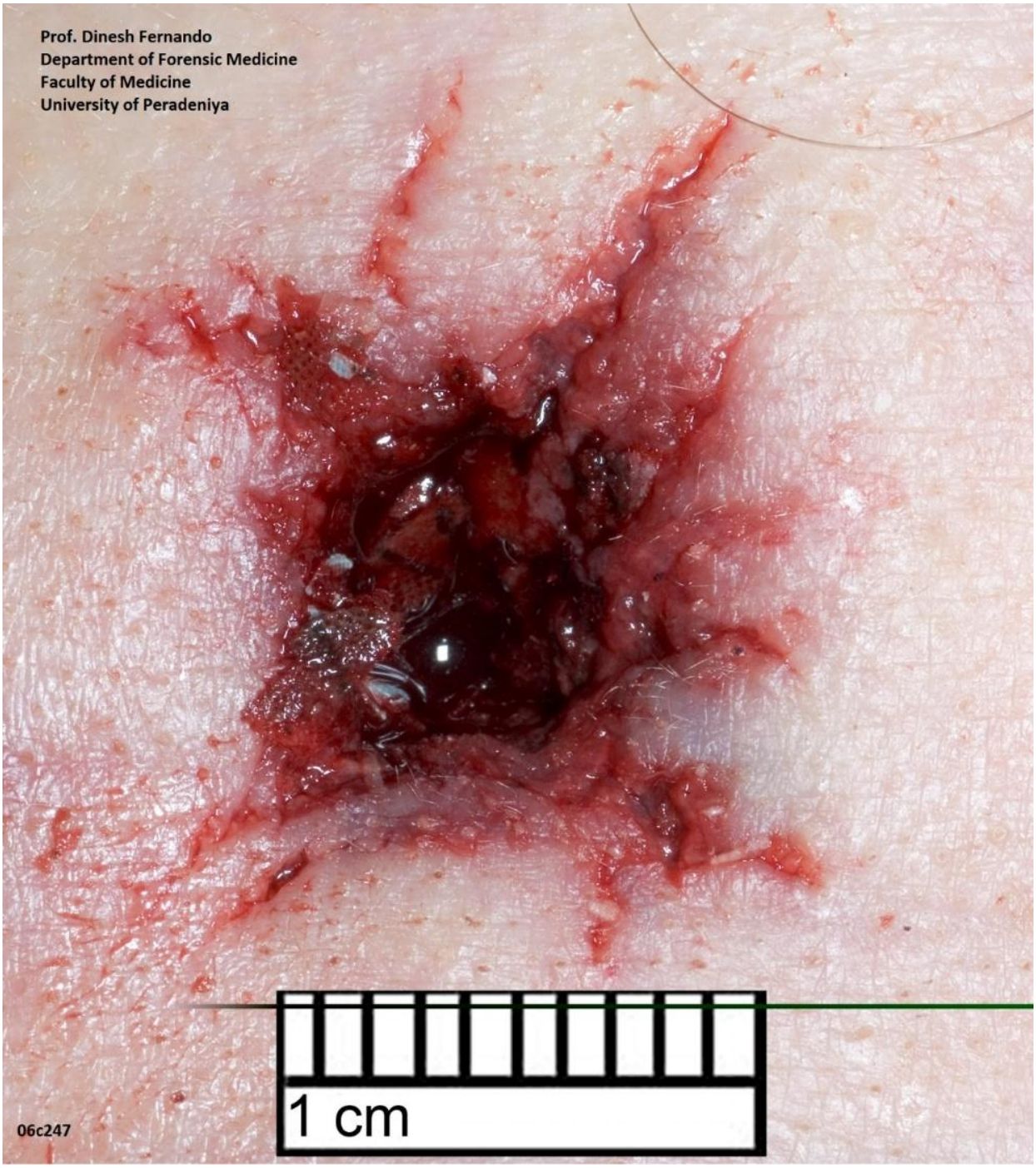


Figure 4: Close up view of injury No.1. Note the superficial micro lacerations radiating outward from the margins of the defect.

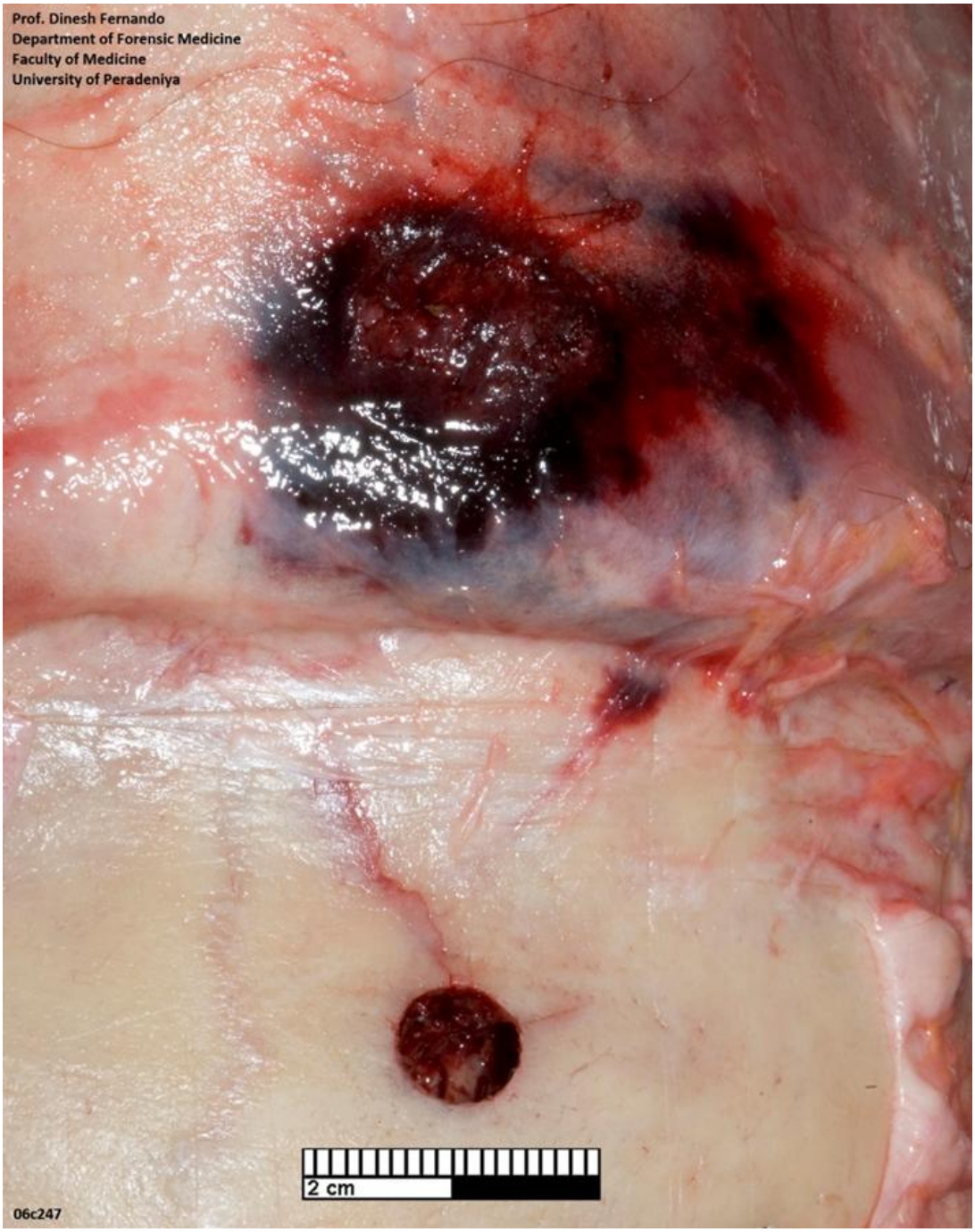
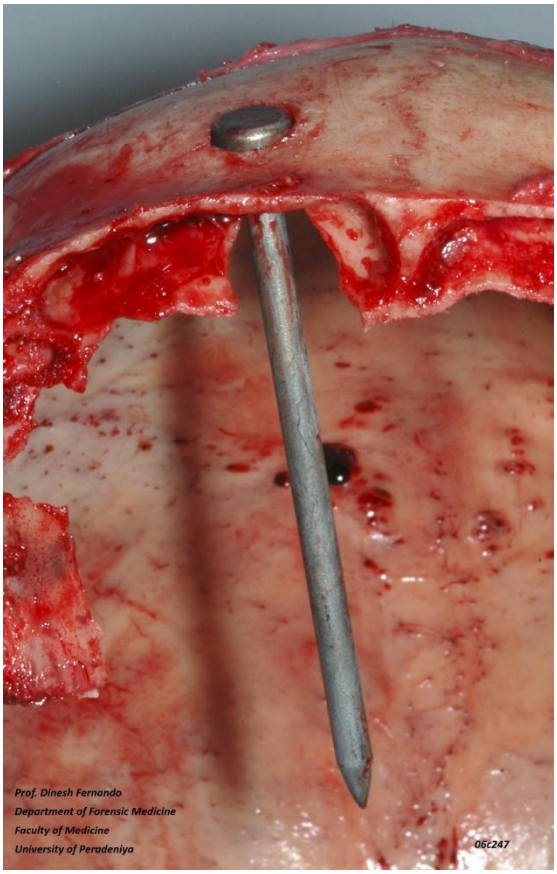
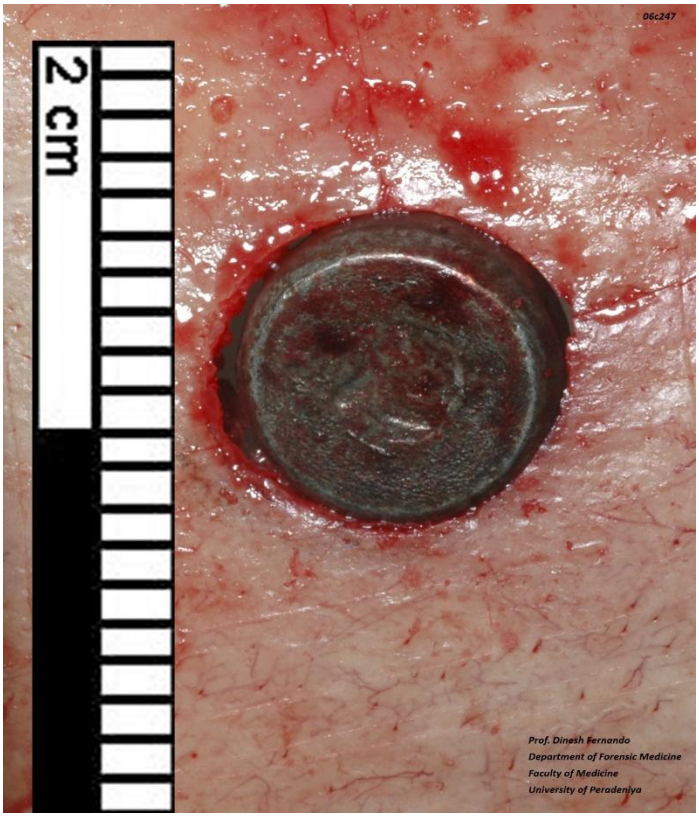


Figure 5: The contused internal aspect of the scalp in relation to external injury No.1. Note the circular deficiency of the frontal bone measuring 8 mm in diameter and the linear fractures extending antero-medially towards the sagittal suture and also laterally to the right.



(a)



(b)

Figure 6: (a), (b) The nail recovered from the car, with a 7 mm head, fitting perfectly in the skull defect

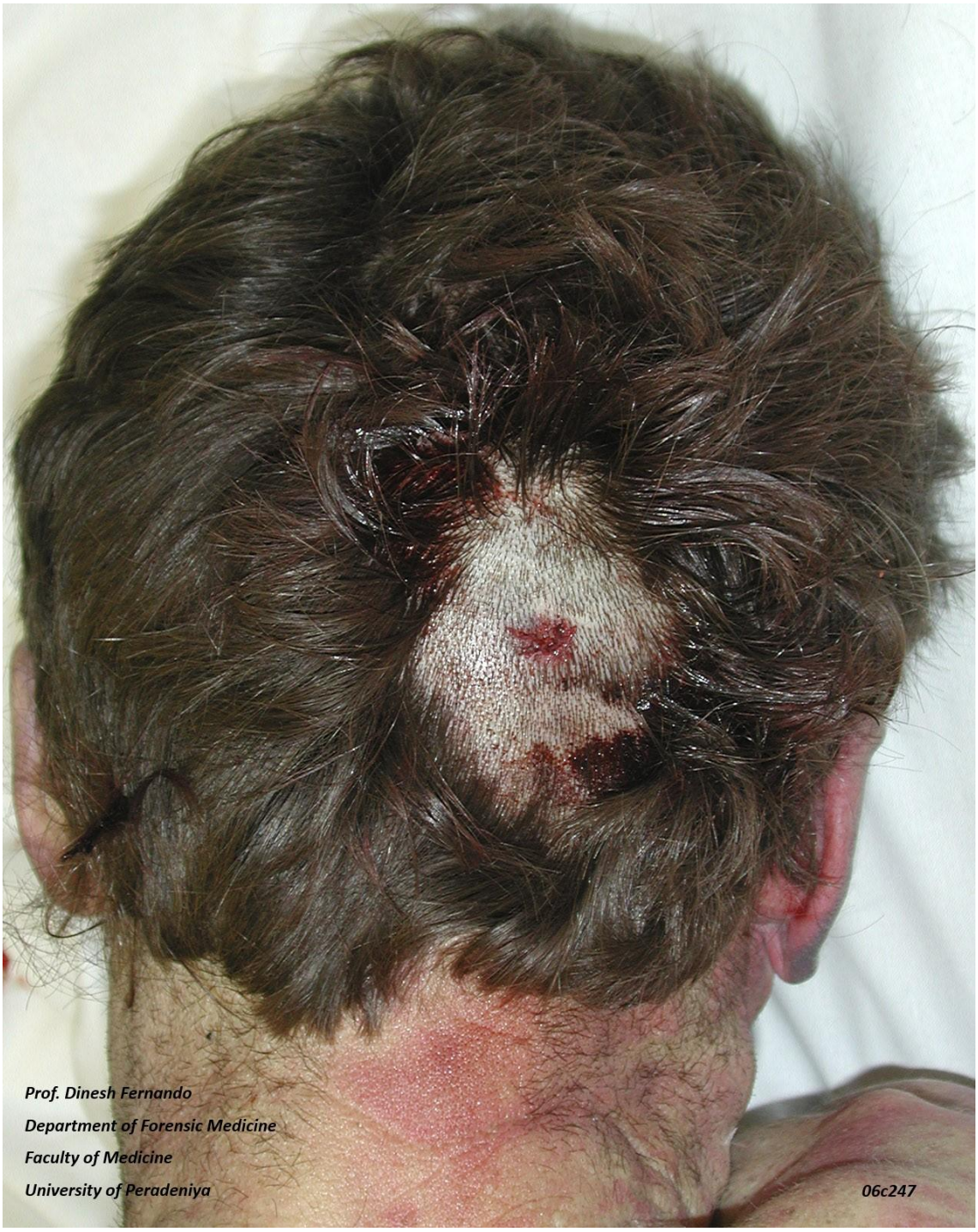


Figure 7: Injury No. 2. A 6 X 3 mm cruciate laceration on the back of the head.

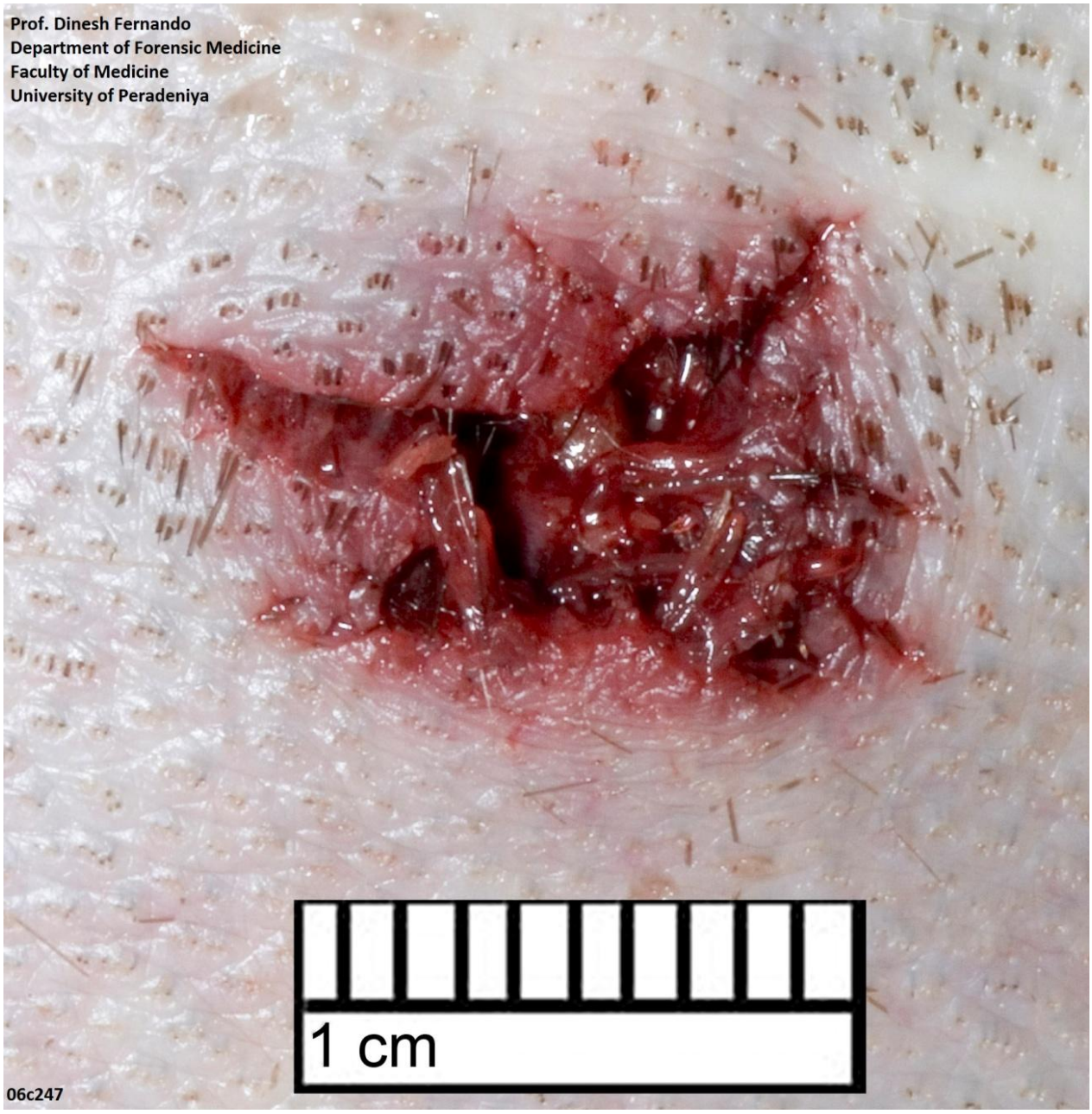
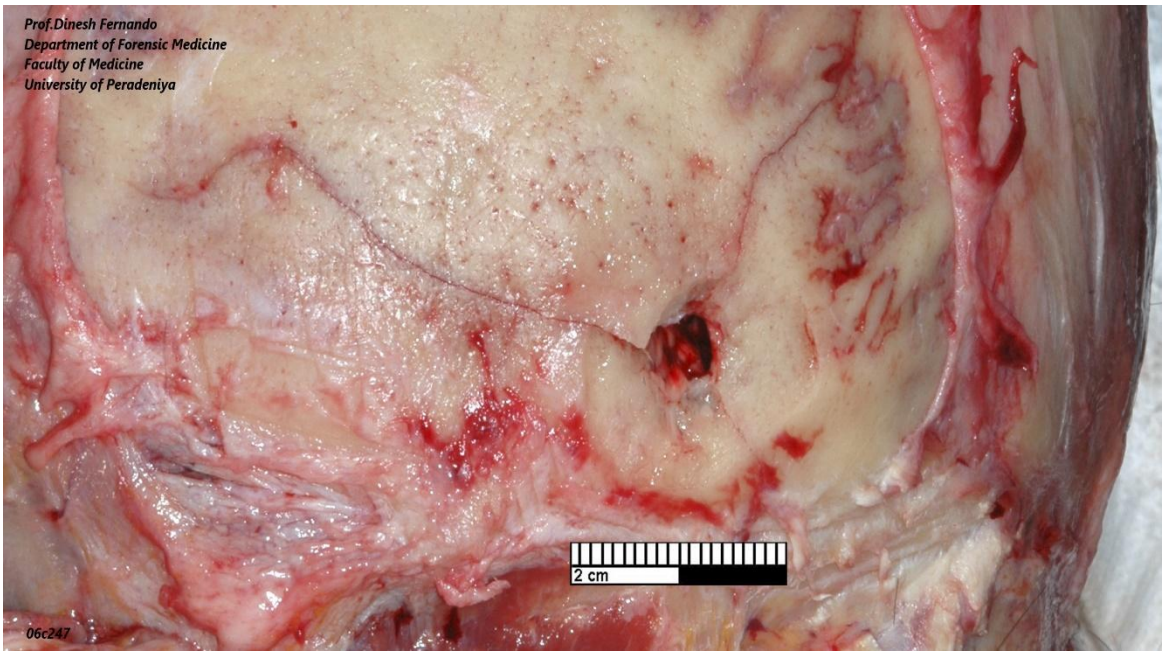
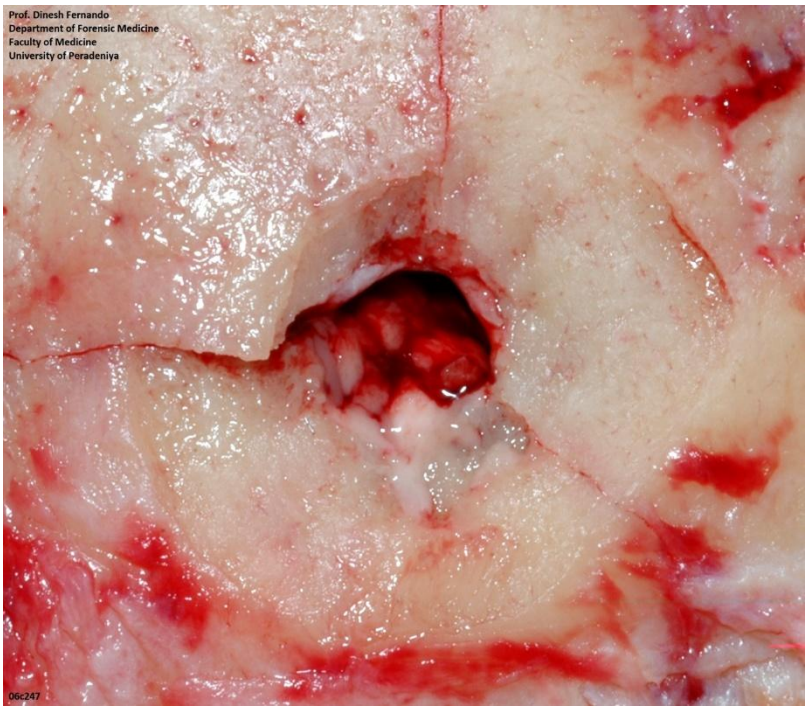


Figure 8: Injury No.2 close up view.



(a)



(b)

Figure 9: (a) Roughly oval deficiency on the occipital bone measuring 8 x 5 mm with external bevelling.

(b) Close up view. Note the radiating fissure fractures to the left, superiorly and inferiorly into the posterior cranial fossa.

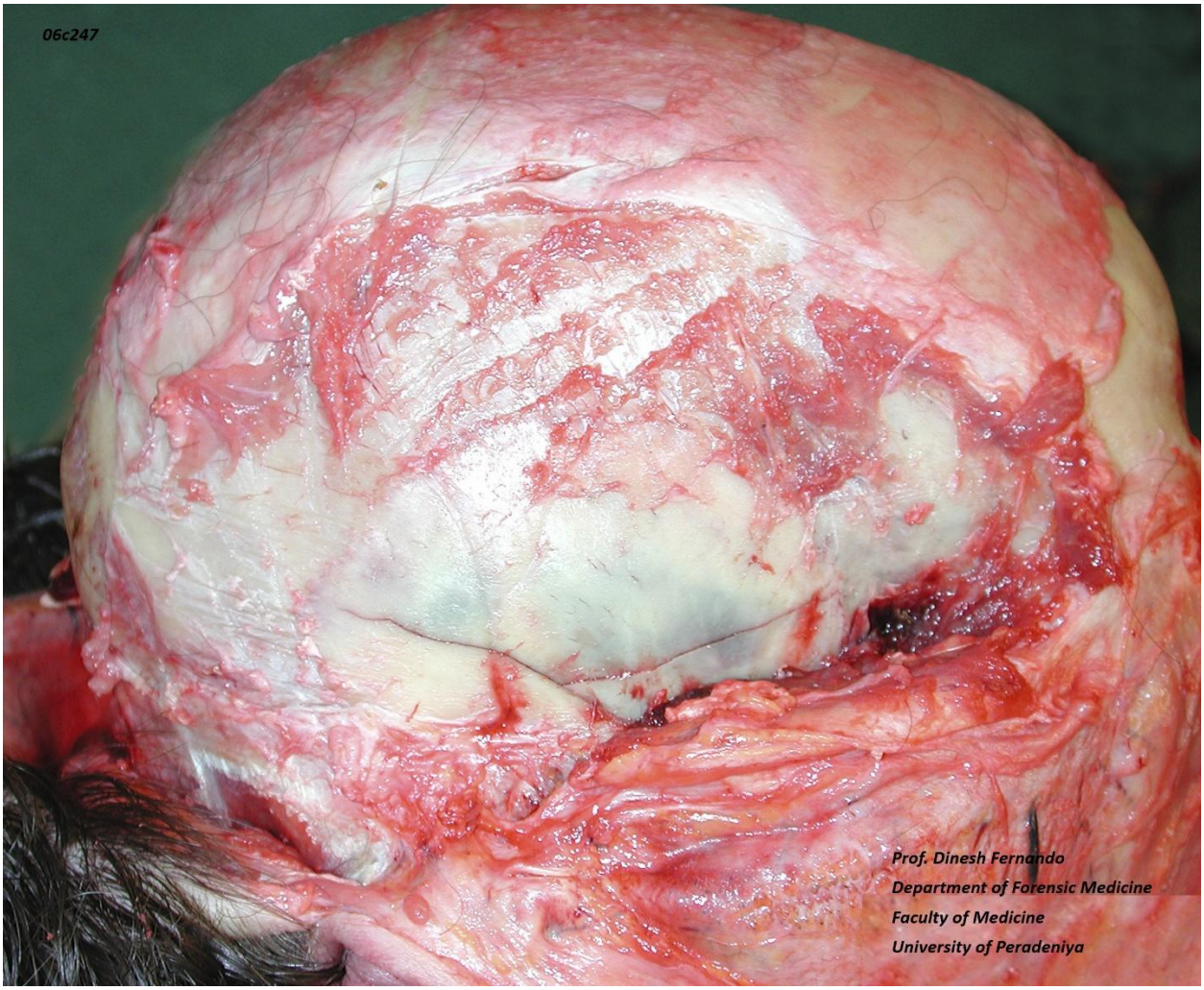


Figure 10: Linear fracture of the right temporal bone with an anterior limb measuring 40 mm and a postero-inferior limb measuring 40 mm.

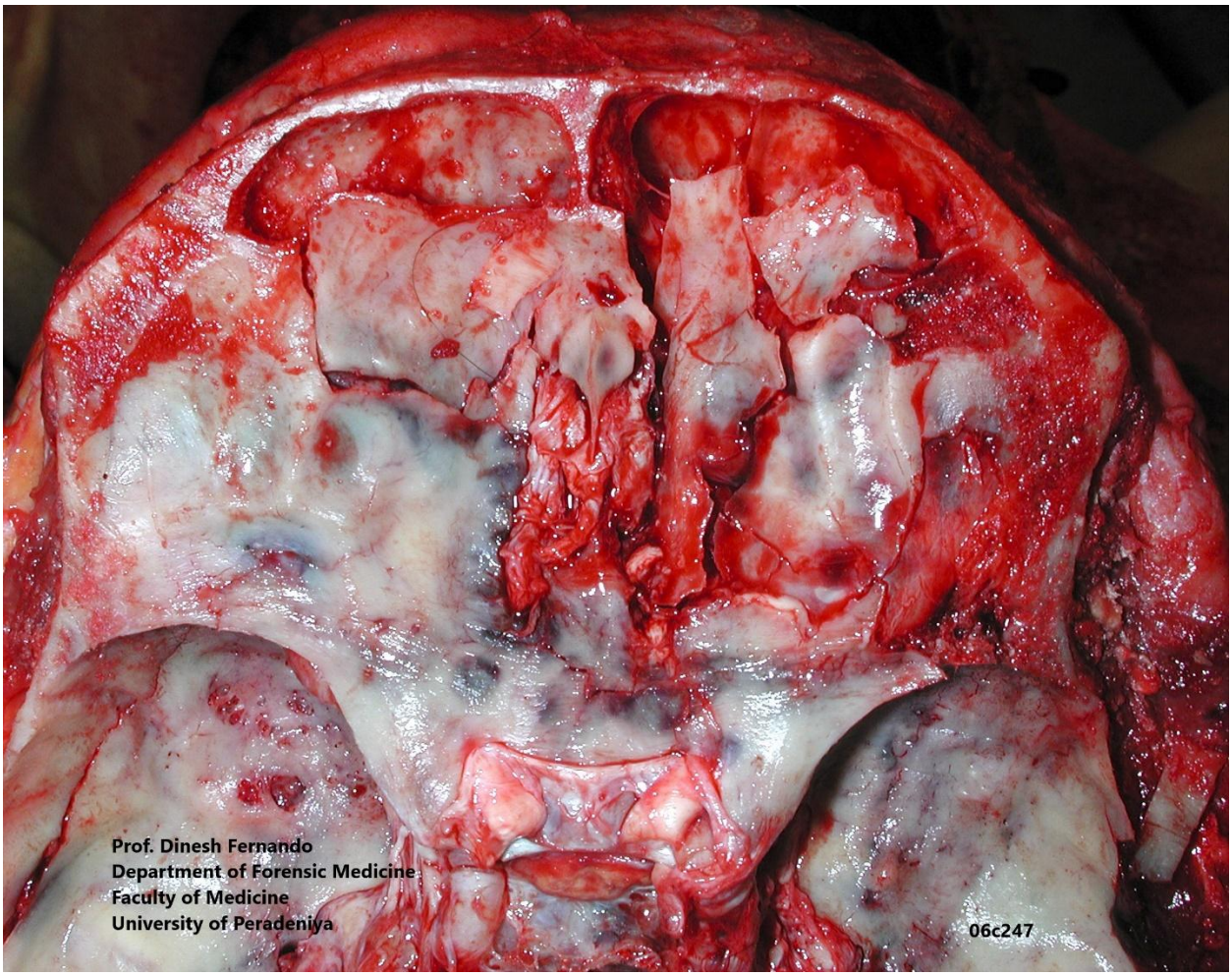


Figure 11: Bilateral fractures of the anterior cranial fossa.

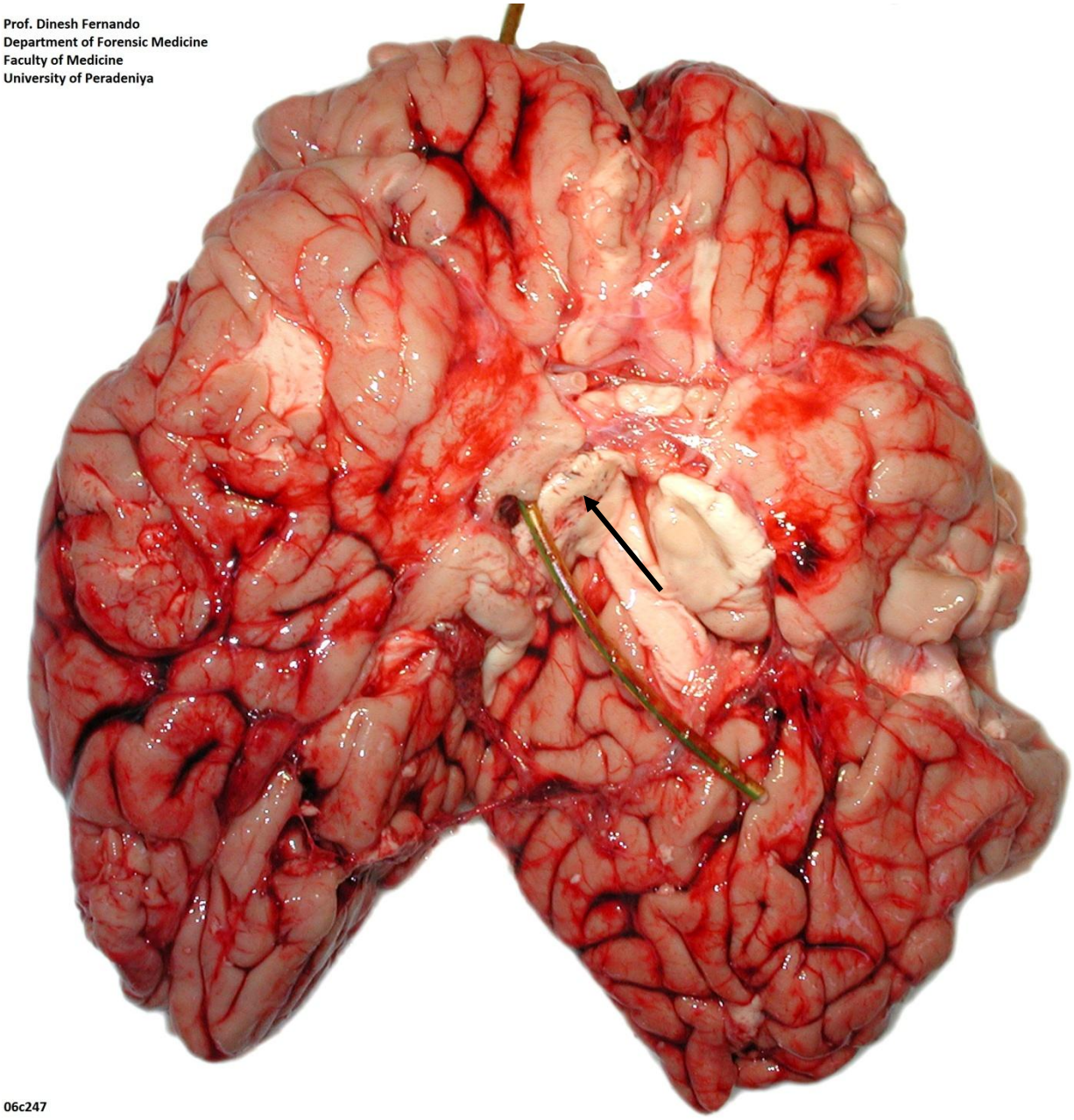


Figure 12: The tract of the missile (nail) through the brain from the right frontal lobe to the right temporal lobe close to the brainstem. Note the thin subarachnoid haemorrhage over the hemispheres and streaky haemorrhages in the mid brain. (Arrow)

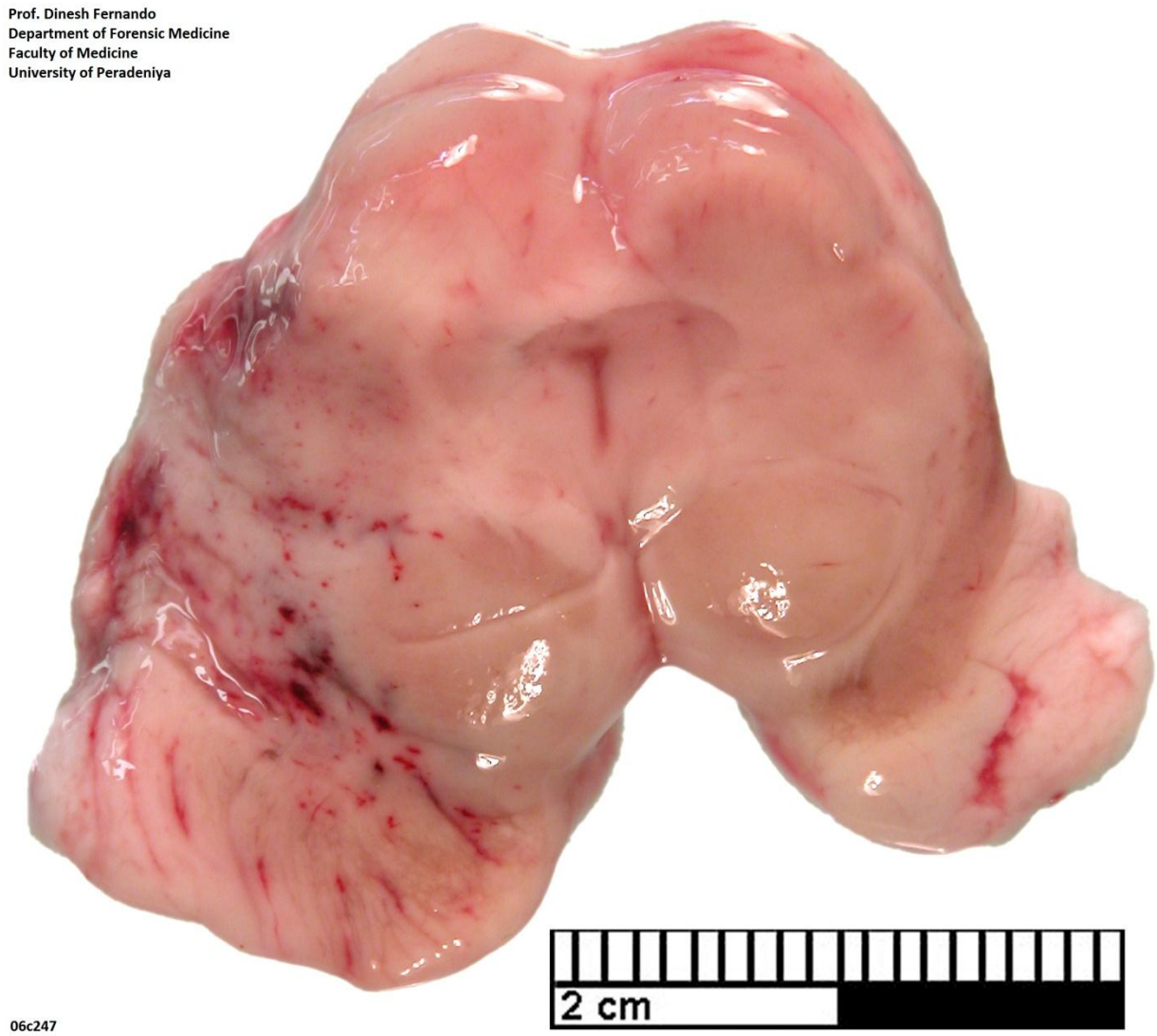


Figure 13: Streaky haemorrhages in the right midbrain and pons.

Figure 14: The 'Ramset' nail gun. Fragments of what appeared to be bone are present at the muzzle end of the gun.

Figure 15: Note the blood, bone, and tissues due to back spatter on the muzzle.

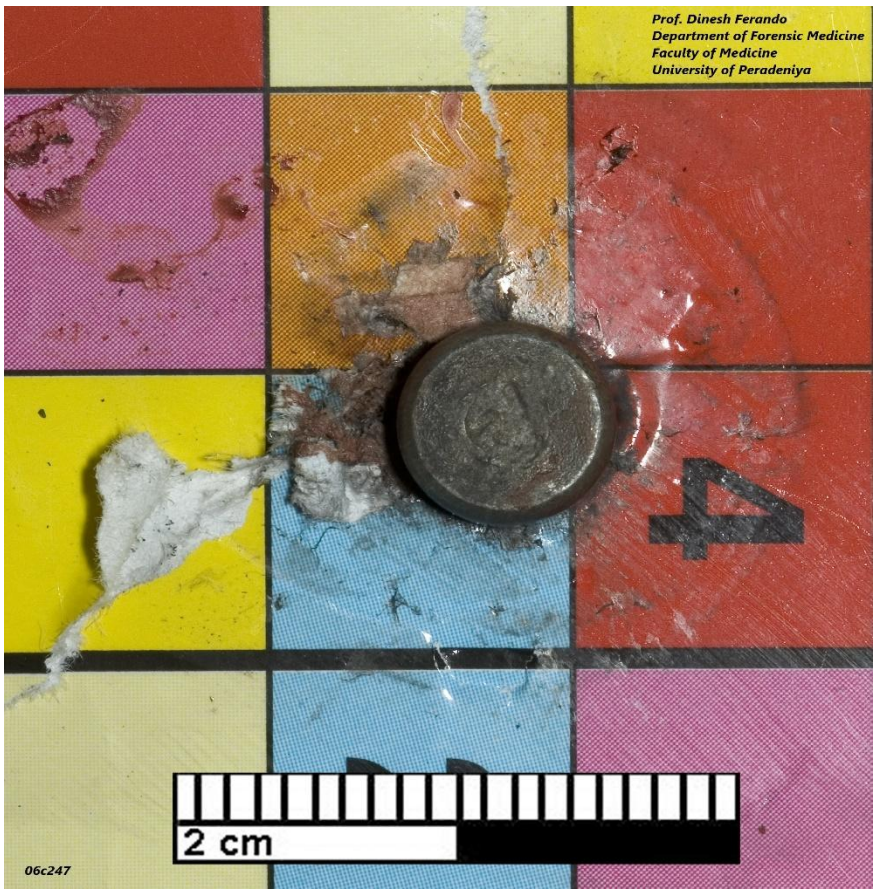


Figure 16: Sudoku book with a hole, the exact diameter of the head of the nail.

Cause of death

Head injury consistent with the history of contact range discharge of a nail from a nail gun. There were no findings on the body to suggest that it was not a self-inflicted injury. The haemorrhage in the brainstem would have caused immediate death.

Trap gun injuries

Trap guns are homemade devices primarily used to kill wild animals. Severe injuries have occurred when humans accidentally trigger these weapons. These are smooth-bore weapons consisting of a cast-iron barrel measuring approximately 2-2½ feet in length, with a bore diameter of about 2 cm (three-quarters of an inch). They are muzzle-loading weapons in which the breech end is permanently blocked and sealed, usually by welding.

The barrel is mounted horizontally on two wooden pegs fixed to the ground, with the nipple facing upward. The height of the barrel from the ground is adjusted according to the expected height of the target animal. Unlike factory-manufactured firearms, trap guns lack uniformity in design and construction, and the ammunition used is highly variable.

A cord (locally known in Sinhala as "maruwela") is stretched across the path that the animal is expected to take. The striker rod is pulled back and held under tension using a short stick positioned between the striker and the breech end of the barrel. This short stick is connected by a string to a vertical trigger mechanism kept under tension. When an animal or a person walks along the path and disturbs the cord, the mechanism releases, allowing the striker to strike the percussion cap and initiate firing. The entire device is usually concealed in nearby bushes approximately 2-3 feet away from the anticipated path.

The basic firing mechanism of a trap gun is broadly similar to that of other firearms, as ignition ultimately leads to the discharge of projectiles through the barrel. However, significant differences exist in the type of ammunition and propellant used. Unlike factory-made firearms that use standardized cartridges containing nitrocellulose-based propellants, trap guns utilize improvised materials. Gunpowder is commonly used as the propellant, and ignition materials may include matchstick heads or firecracker powder. Pellets and projectiles are also improvised and may vary widely in size, shape, and composition.

Due to the absence of standardized ammunition, the firing range of trap guns cannot be accurately calculated. Consequently, the wound patterns produced are highly variable and unpredictable, depending on factors such as the type and quantity of propellant, nature of the pellets, distance from the victim, and stability of the device at discharge.

History

A 47-year-old farmer sustained injuries to his left lower limb following discharge of a trap gun while walking along a footpath in a jungle. He was admitted to hospital and underwent wound toilet and external fixation. Two pellets were recovered from the wound.

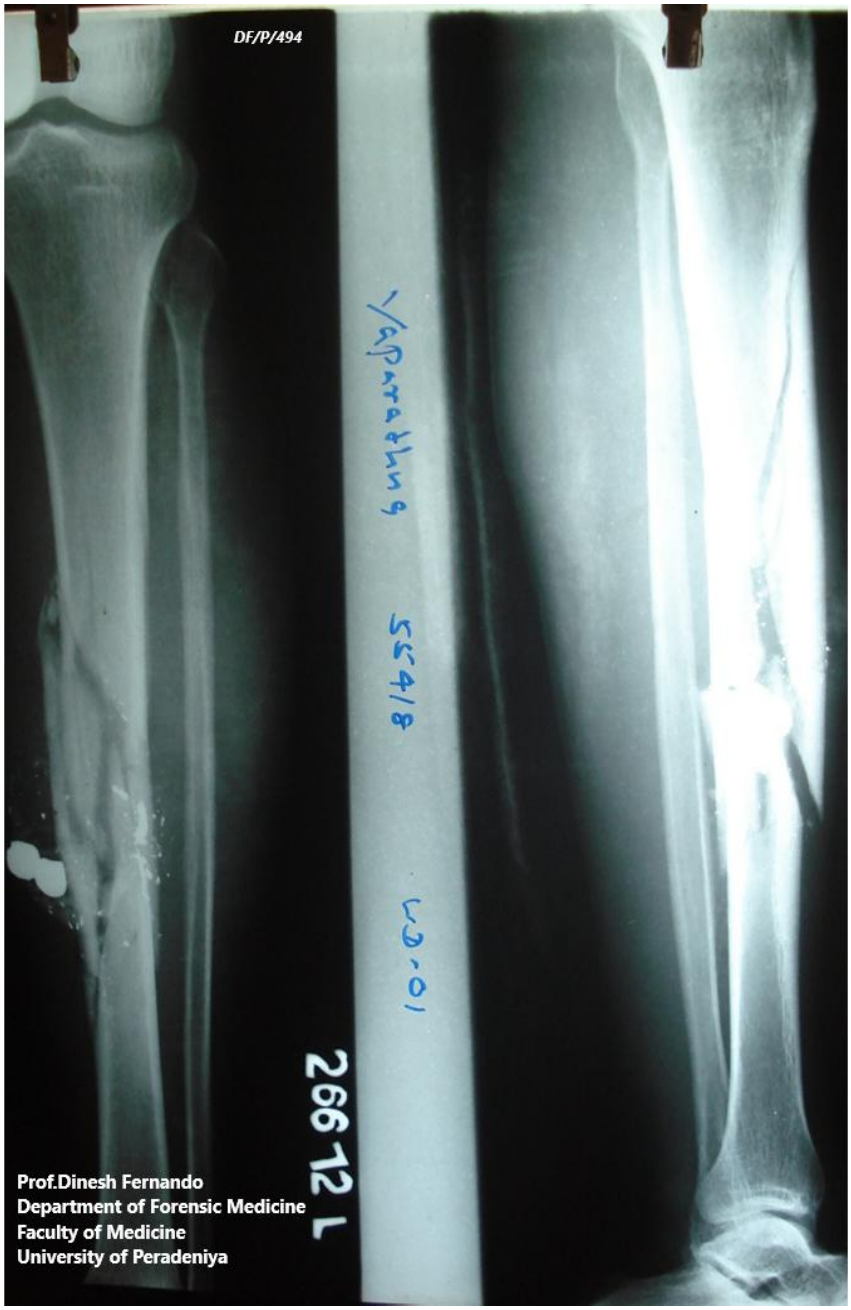


Figure 17: X-ray of left leg showing a comminuted fracture of the left tibia.
Note the radio opaque circular objects (pellets) and minute radio opaque particles (lead dust).

Figure 18: Two improvised pellets 10 mm in diameter recovered from the wound.

History

A 46-year- old male worker in a farm sustained a gunshot injury to his left leg while walking along a path within the farm premises. He was admitted with severe bleeding to a local hospital and then transferred to the teaching hospital Peradeniya. On admission he was intubated and resuscitated with blood and blood products. Since his lower limb was found to be non-viable an above knee amputation was done, and sent for medico-legal examination.

Medico legal examination of the amputated limb

External examination - Five irregularly circular penetrating lacerations, with varying sizes were present on the medial aspect of the left thigh. These were dispersed in an area of 8 cm x 8 cm in size and the midpoint was situated 42 cm above the medial malleolus and 8 cm medial to the anterior midline.

Two irregular shaped lacerations were present on the lateral aspect of the left thigh. Both were 44 cm above lateral malleolus and 10 cm lateral to the anterior midline.

Internal injuries- Extensive multiple comminuted fractures of the left lower femur, associated with laceration of the popliteal artery and the surrounding muscles was present.

Multiple pellets and their fragments were recovered from the wound.

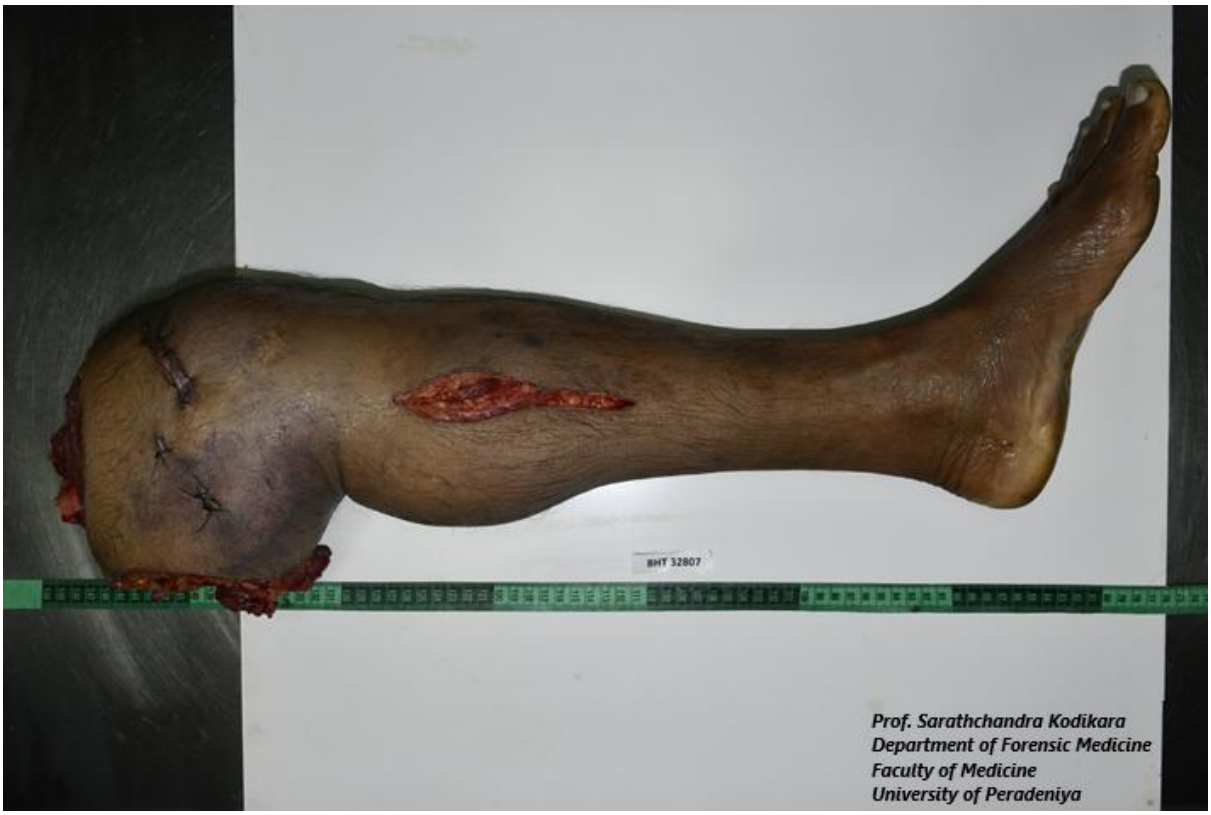


Figure 19: Amputated limb with sutured lacerations and a fasciotomy.

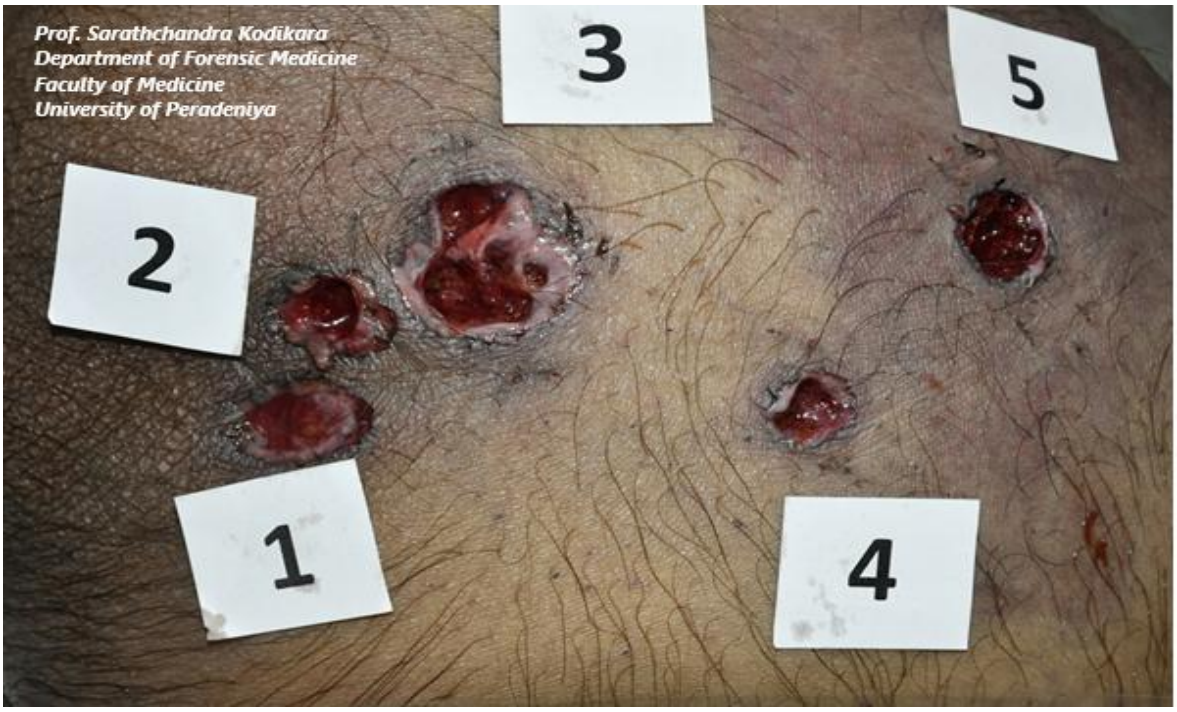


Figure 20: Penetrating lacerations of varying sizes and shapes seen on medial aspect of the left thigh following removal of sutures. Note blackening around the wounds.

Figure 21: Lateral aspect of the left thigh showing two irregular shaped lacerations.

Figure 22: Trap gun constructed using locally available materials.

Figure 23: Close up view.

Figure 24: Close up view of the trigger mechanism.

Opinion

Smooth bore firearm injury at close range. Firearm entry is on the medial aspect of left lower thigh and exit is on the lateral aspect of left lower thigh. Directed upwards and slightly backwards and some pellets have not exited.

History

A 24-year-old male had placed a loaded homemade gun horizontally in a hiding place. When he had attempted to retrieve it by pulling the barrel, it had discharged and he sustained a gunshot injury to his right upper limb.

Figure 25: A locally made gun with a smooth bore barrel and a trigger mechanism.

Figure 26: Close up view of the trigger mechanism.

Figure 27: Smooth bore cast iron cylinder with a diameter of 15 mm.

History

A 60-year-old male, was shot with a long barrelled weapon from a distance of around 4 m [15 feet]. He was shot once from the front and he defended with his left hand in front of his body and then lost consciousness. Surgery was done at Peradeniya hospital and according to hospital notes, arteries and veins of left upper limb were lacerated and there was no blood flow to the distal part of the hand. End to end anastomosis using a saphenous vein graft was done. A lack of power and sensation was present due to damage to the nerves.

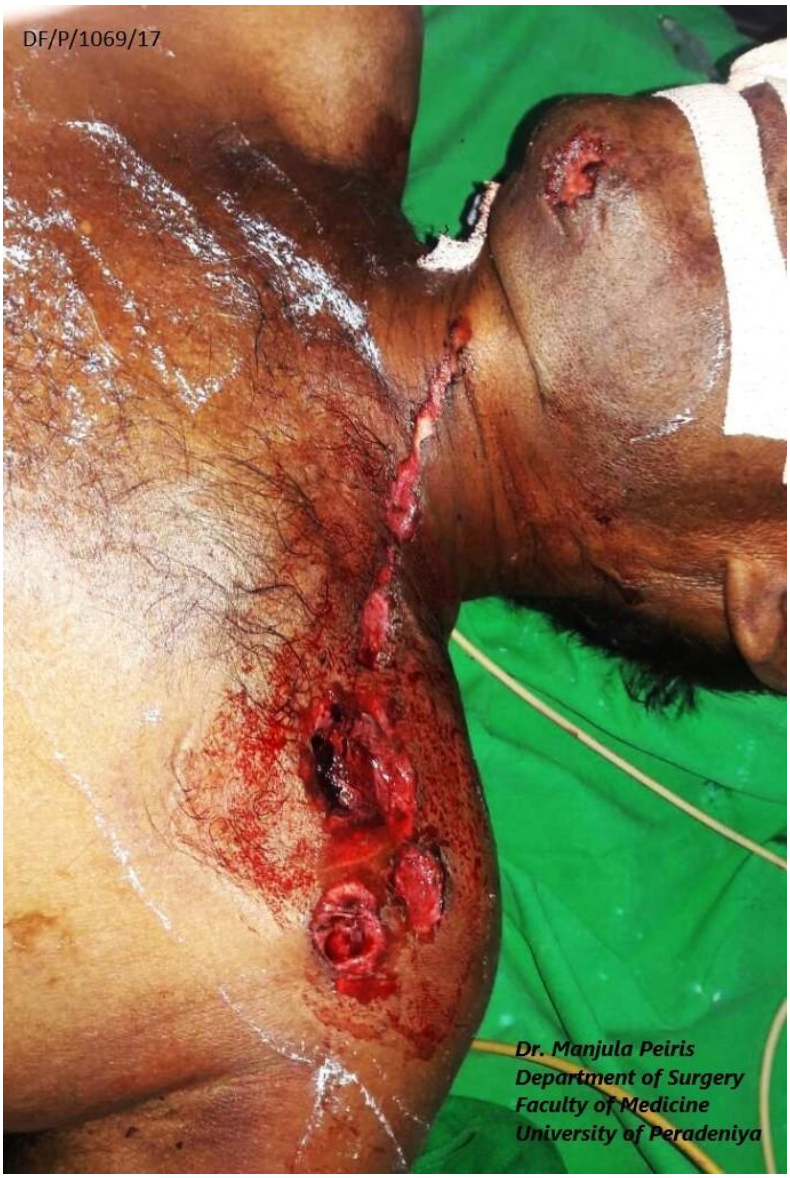


Figure 28: An irregularly circular laceration on the tip of chin, a linear laceration extending from the middle of the neck towards left shoulder and a large irregularly circular penetrating laceration associated with two other lacerations on front of the left shoulder.

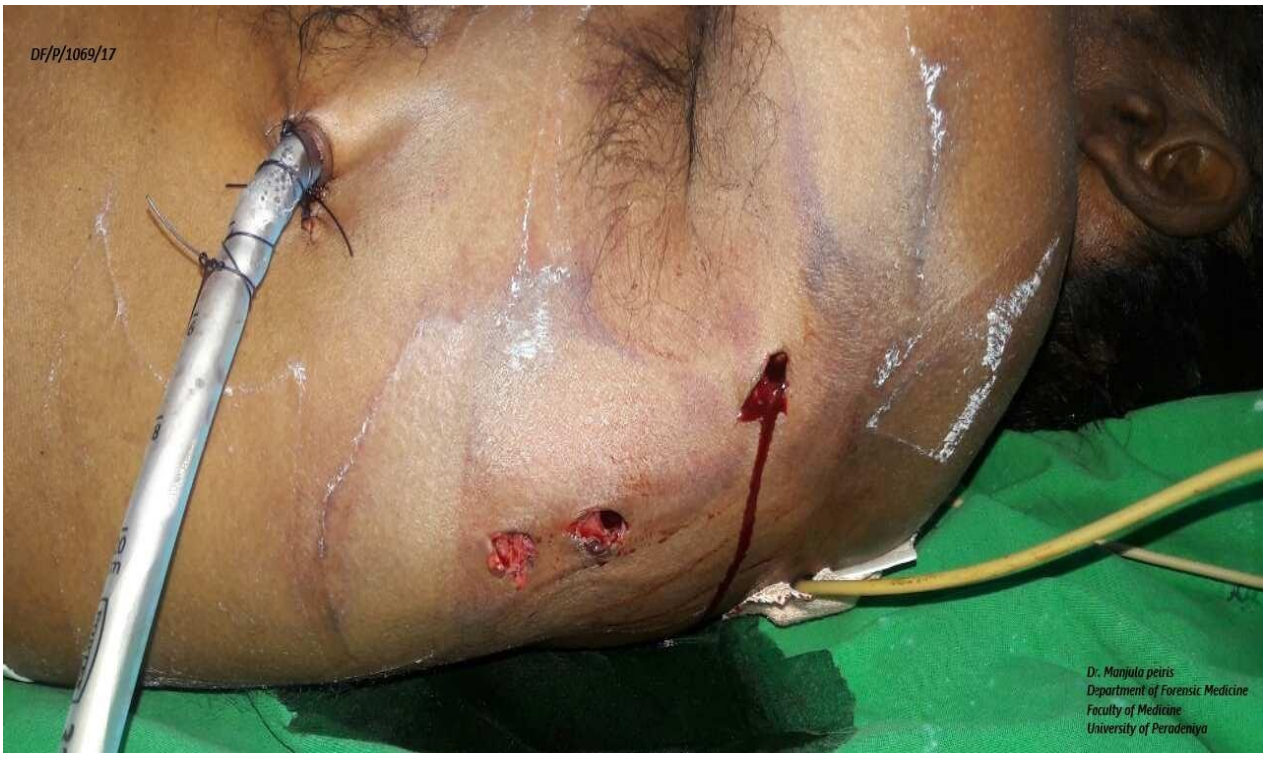


Figure 29: Three irregularly circular lacerations, 10 mm in diameter, on the left posterior axillary fold are present.

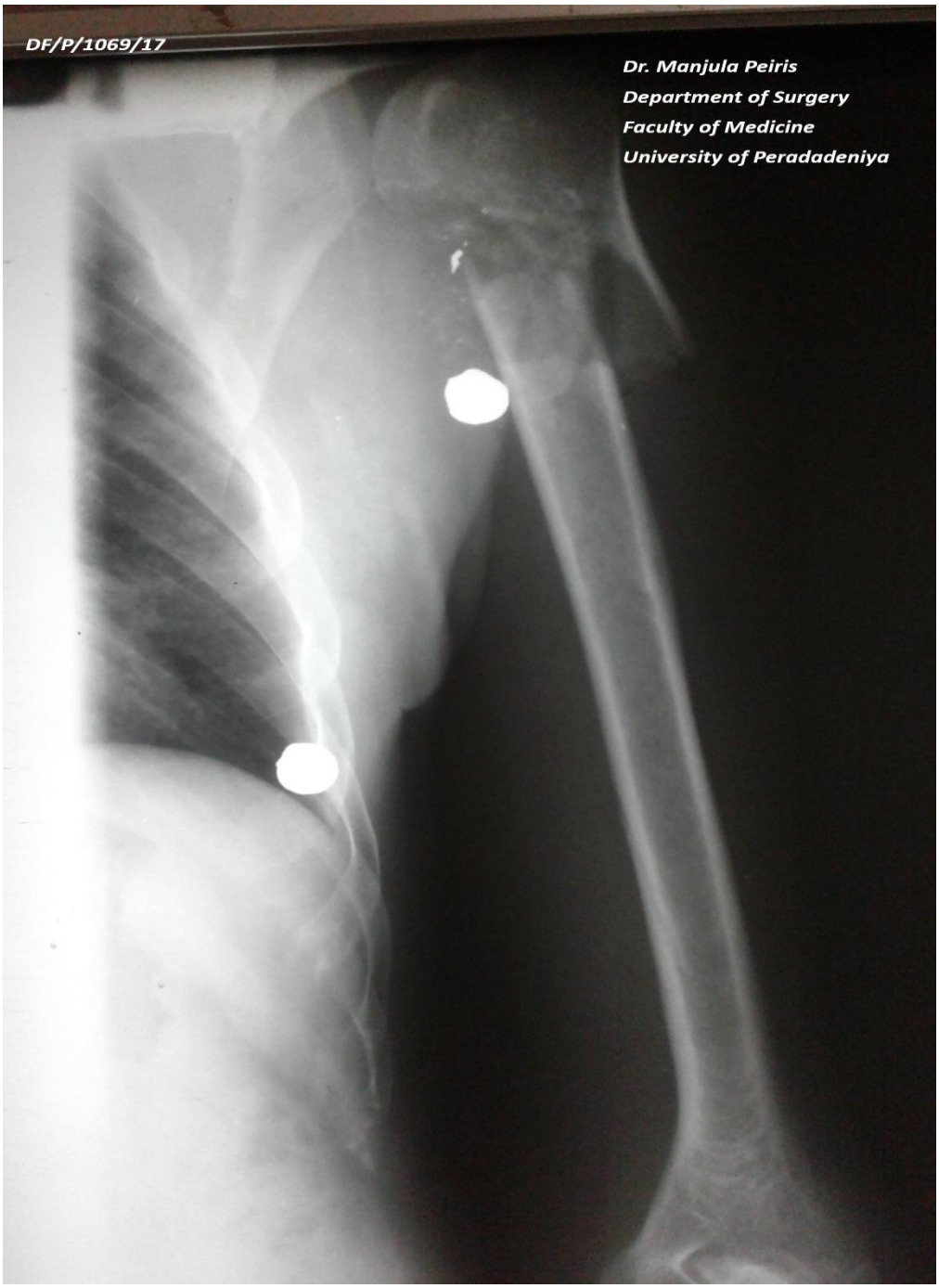


Figure 30: Compound, comminuted fracture of upper left humerus is present.
Note two spherical radio opaque objects (pellets) visible on X-ray.

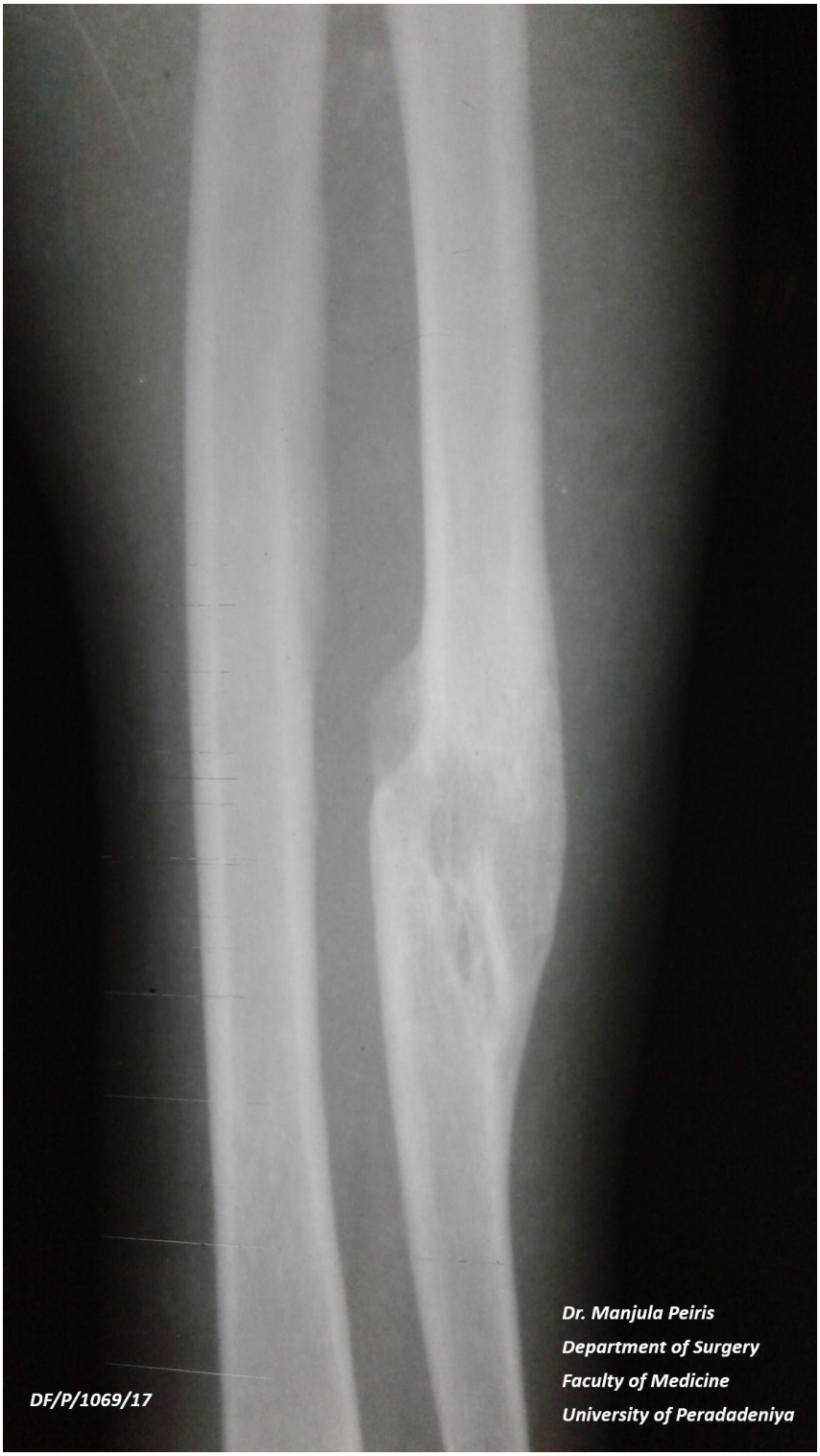


Figure 31: A healed fracture in the middle 1/3rd of left ulna is seen.

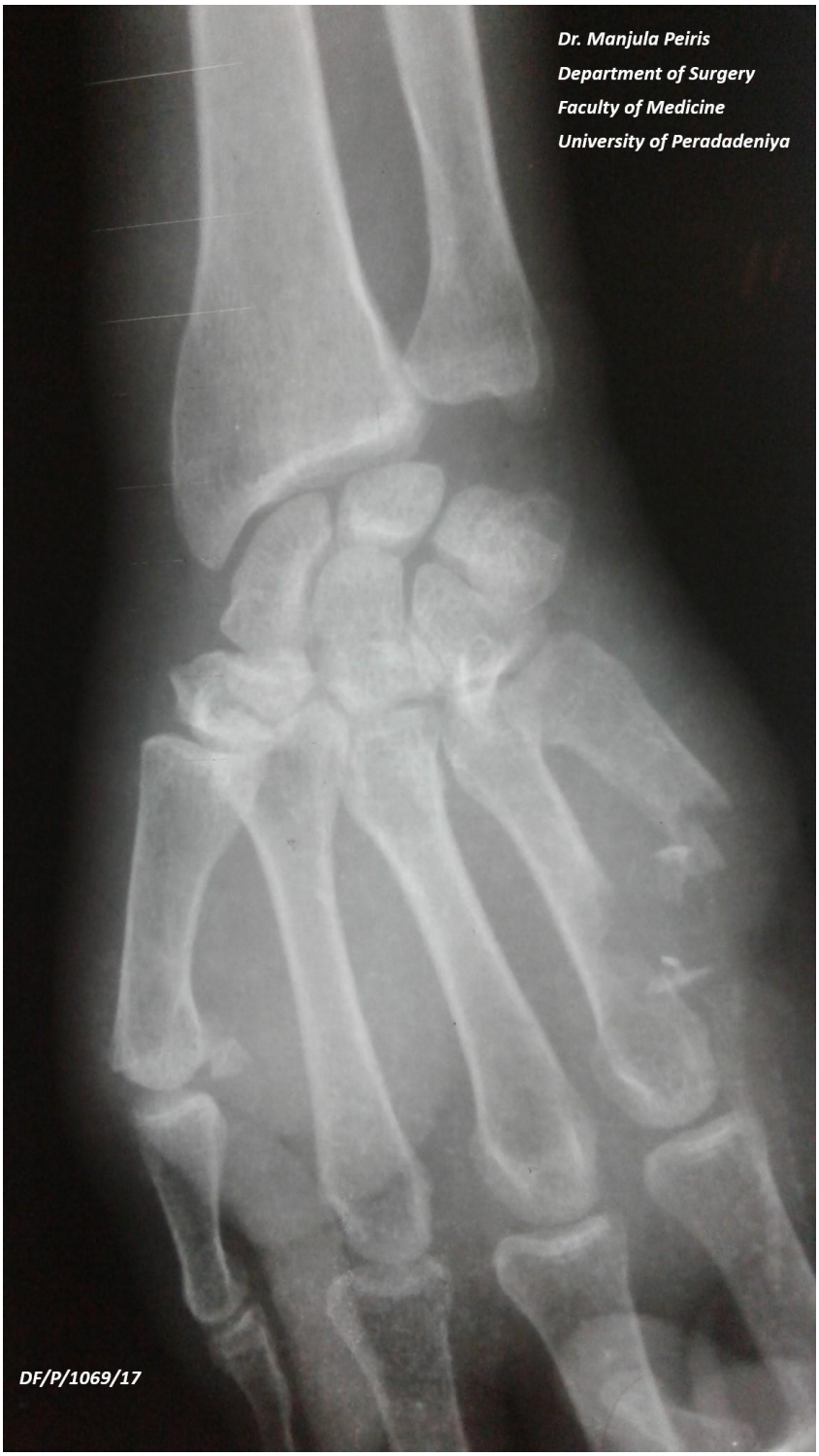


Figure 32: Complete fracture of metacarpal of left 5th finger with loss of distal part and partial fracture of metacarpal of left 4th finger.

Opinion

Patient was shot at with a smooth bore weapon discharged from front and to his right side directed slightly downwards and backwards. The pellets had entered the front of chest just below left shoulder and exited from the postero-lateral aspect of left chest.

Prior to entering the chest, the pellets have grazed the chin and anterior aspect of chest. The injury to left hand is likely a defensive injury where the hand was placed in front of face and was caused by pellets striking left 4^{th} and 5^{th} fingers.

History

A 31-year-old male, who was walking to his paddy field in the evening, sustained firearm injuries to his lower limbs. Multiple penetrating/puncture lacerations were present in the postero-medial aspect of his right lower thigh and posterior aspect of left calf. No injuries present on the opposite side (exit wounds). The right popliteal vein and nerve was intact. Part of the popliteal artery was damaged. Right side fasciotomy and reverse saphenous vein interposition graft to the right popliteal artery was done.

Figure 33: Multiple penetrating/puncture lacerations of 5 mm diameter in an area of 8x8 cm on the posterior aspect of the left calf. Note the guttering of skin due to some pellets skimming along the skin (Black arrow).

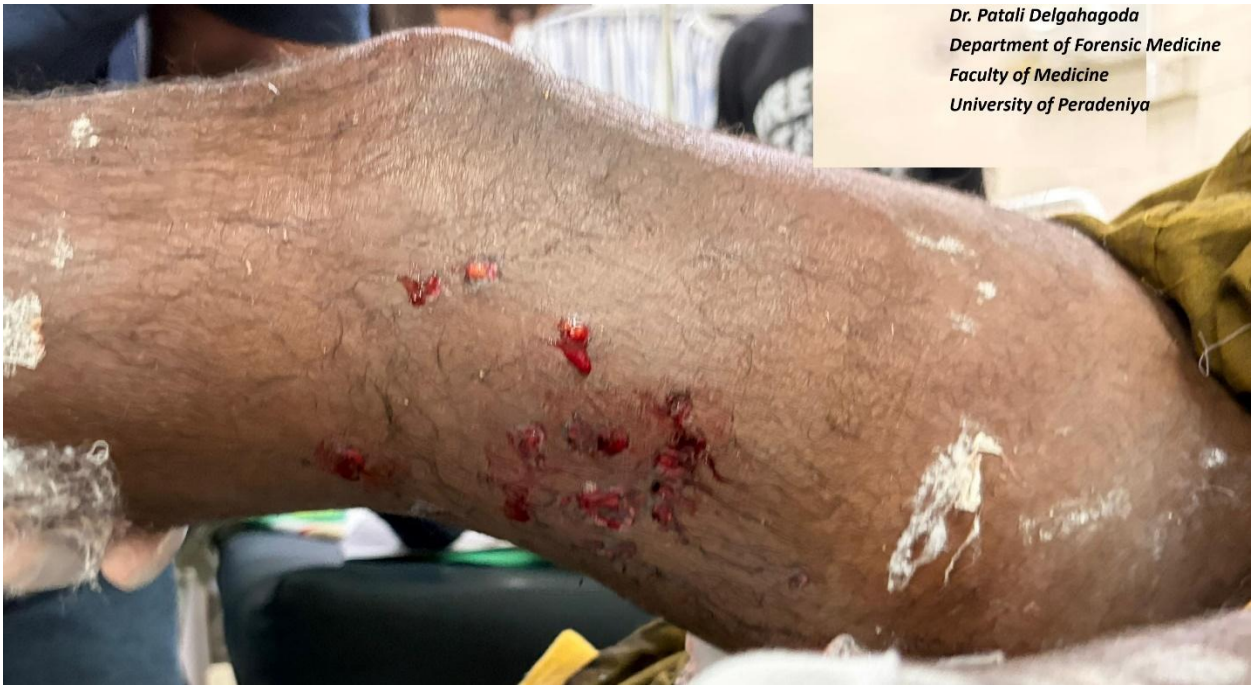
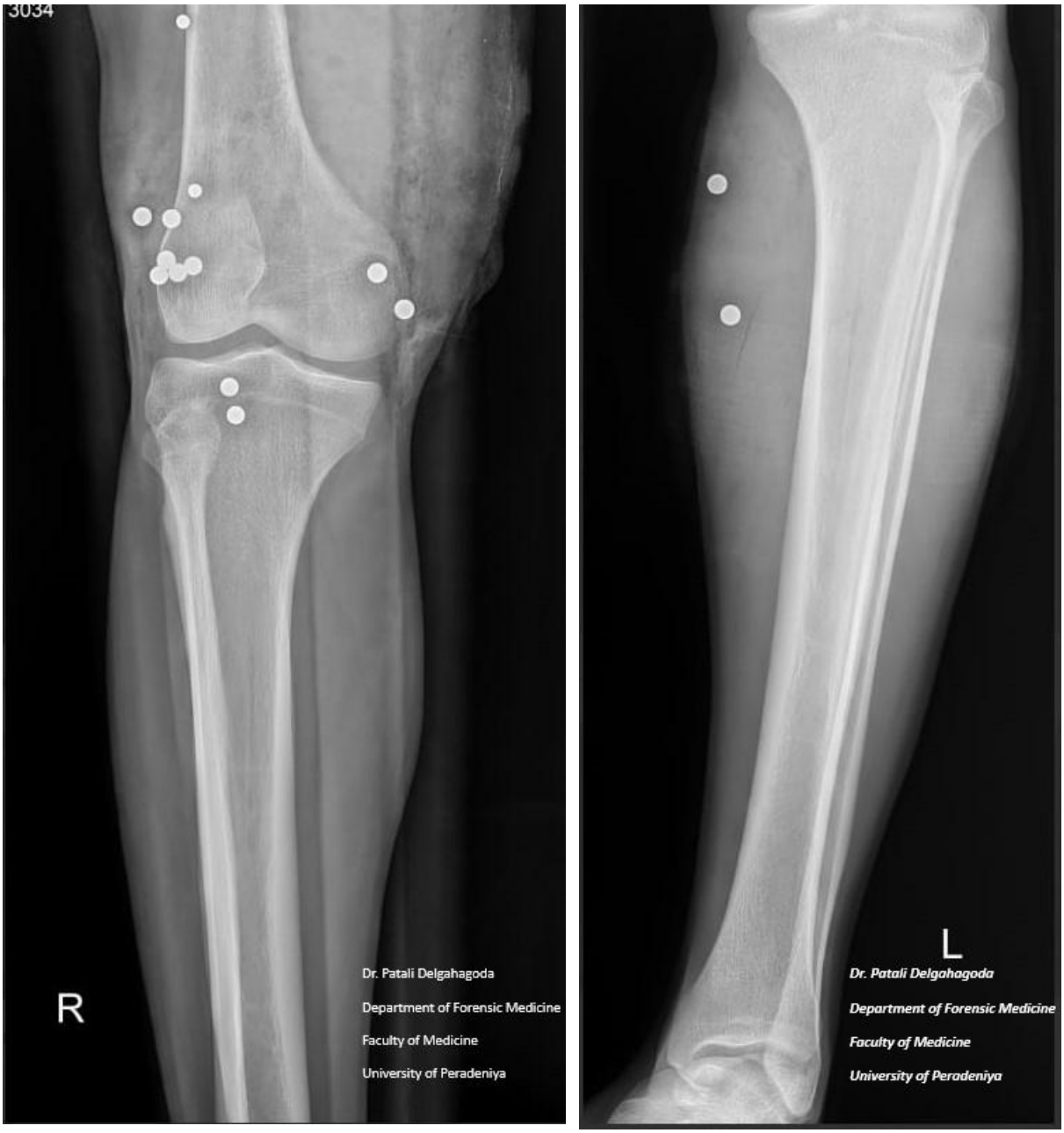


Figure 34: Multiple penetrating lacerations in the postero medial aspect of the right lower thigh.



(a) (b)

Figure 35: Circular hyperdense objects. (a) Twelve in right lower thigh (b) Two in left upper calf.

Figure 36: Two of the pellets retrieved during surgery.

Opinion

Injuries are caused by pellets of a smooth bore weapon. Injury pattern is compatible with discharge of a trap gun placed approximately 40 – 50 cm above the ground. Some pellets may have been removed or dislodged prior to imaging, since there are only 2 hyperdense objects seen in the left calf even though there are more injuries on the skin. Range is beyond burning, blackening and tattooing. However since homemade ammunition has been used it is not possible to comment further. Category of hurt is endangering life.

History

A 3-year-old male child presented with a circular perforated laceration, nasal bleeding and aspiration of blood. Imaging studies revealed a diabolo shaped foreign body resembling a pellet of an air gun in the left pharyngeal space. The foreign body was removed under image guidance. Investigation revealed that the parents used an air gun on the farm to protect their crops from monkeys and it was concluded that another child had fired the weapon accidentally, during play.

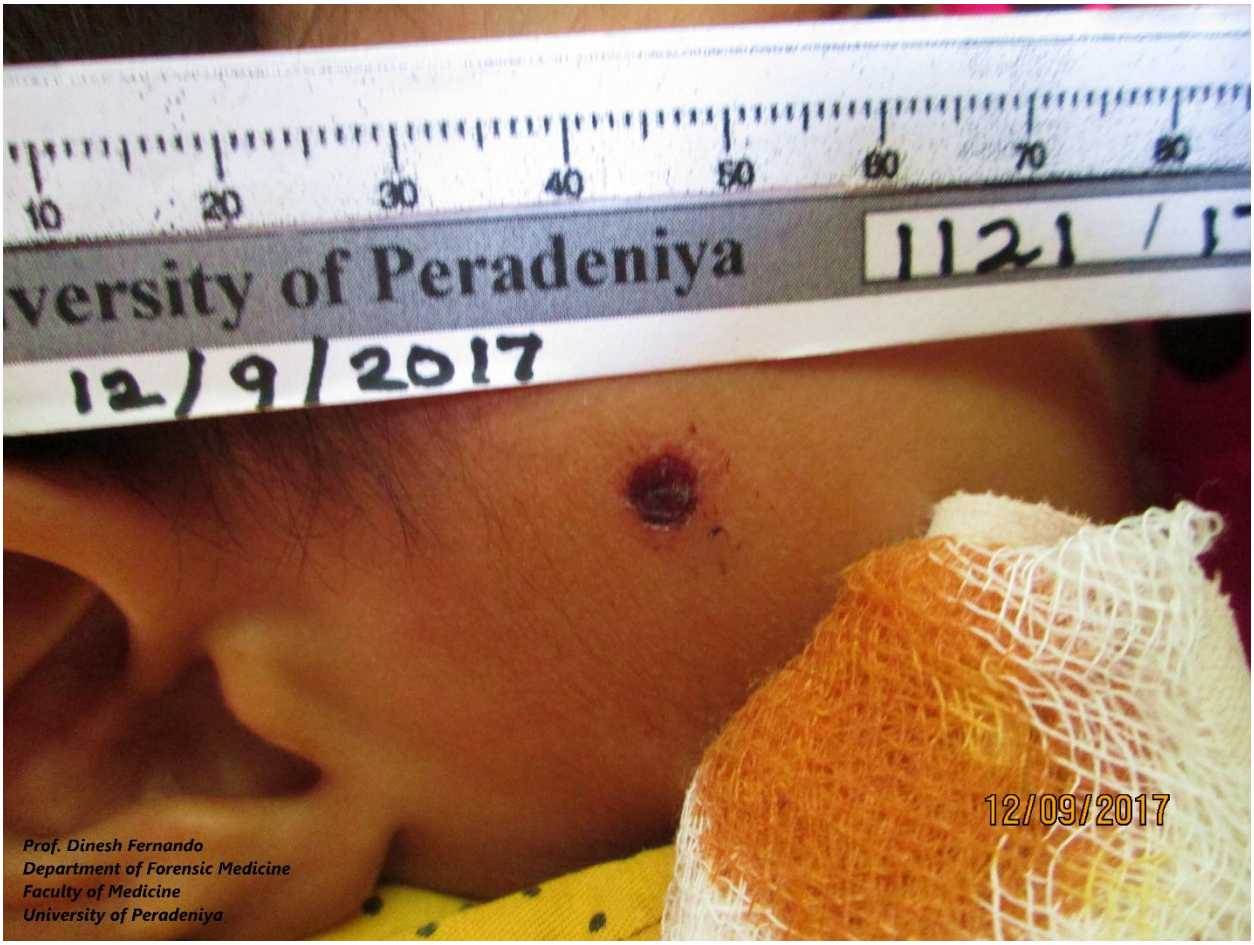


Figure 37: A circular perforated laceration 5 mm in diameter on the right side of the face over the zygomatic arch.

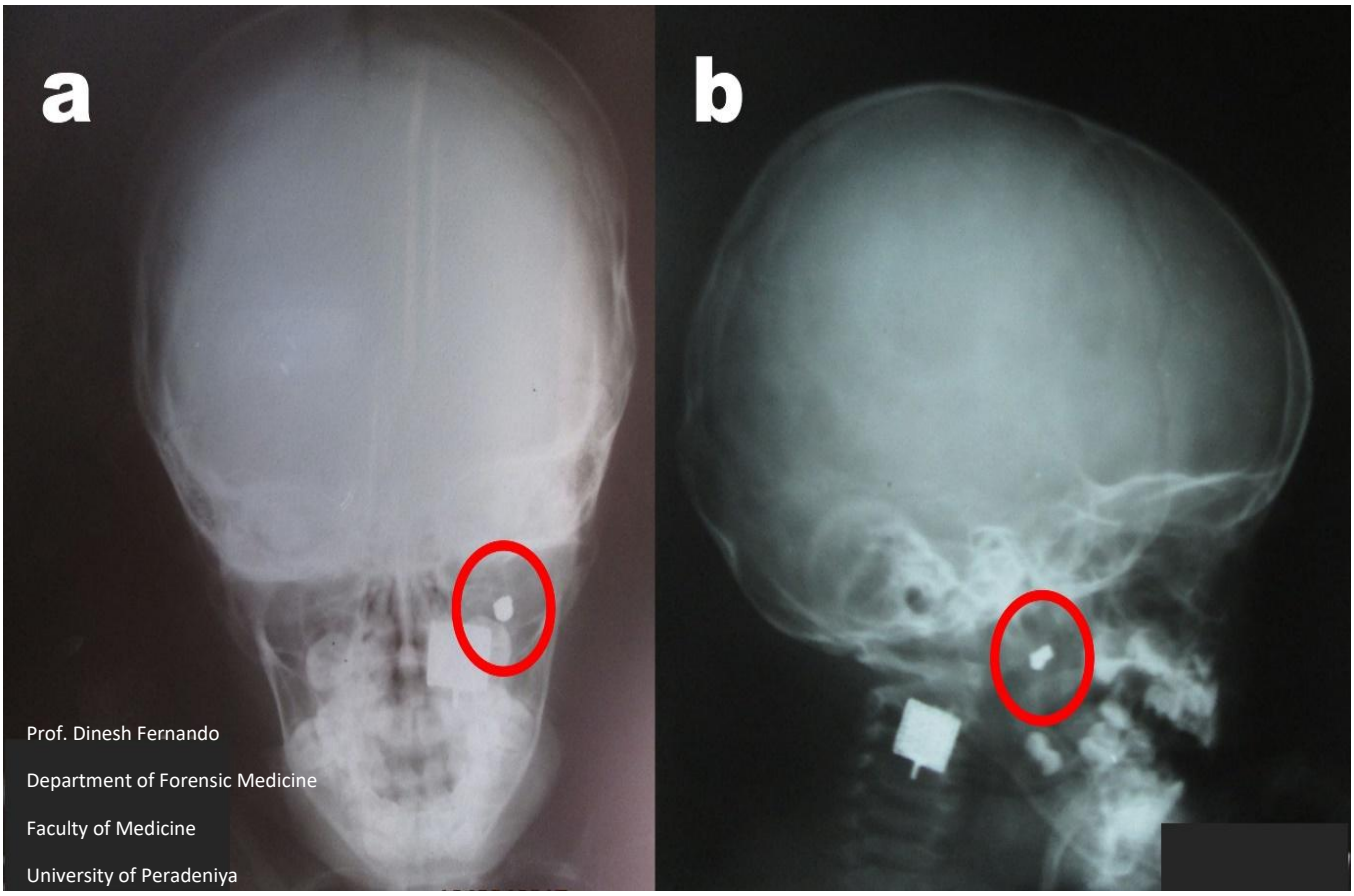


Figure 38: X-ray skull showing a diablo shaped radio-opaque object in the left side of the face (circle); (a) PA view, (b) lateral view

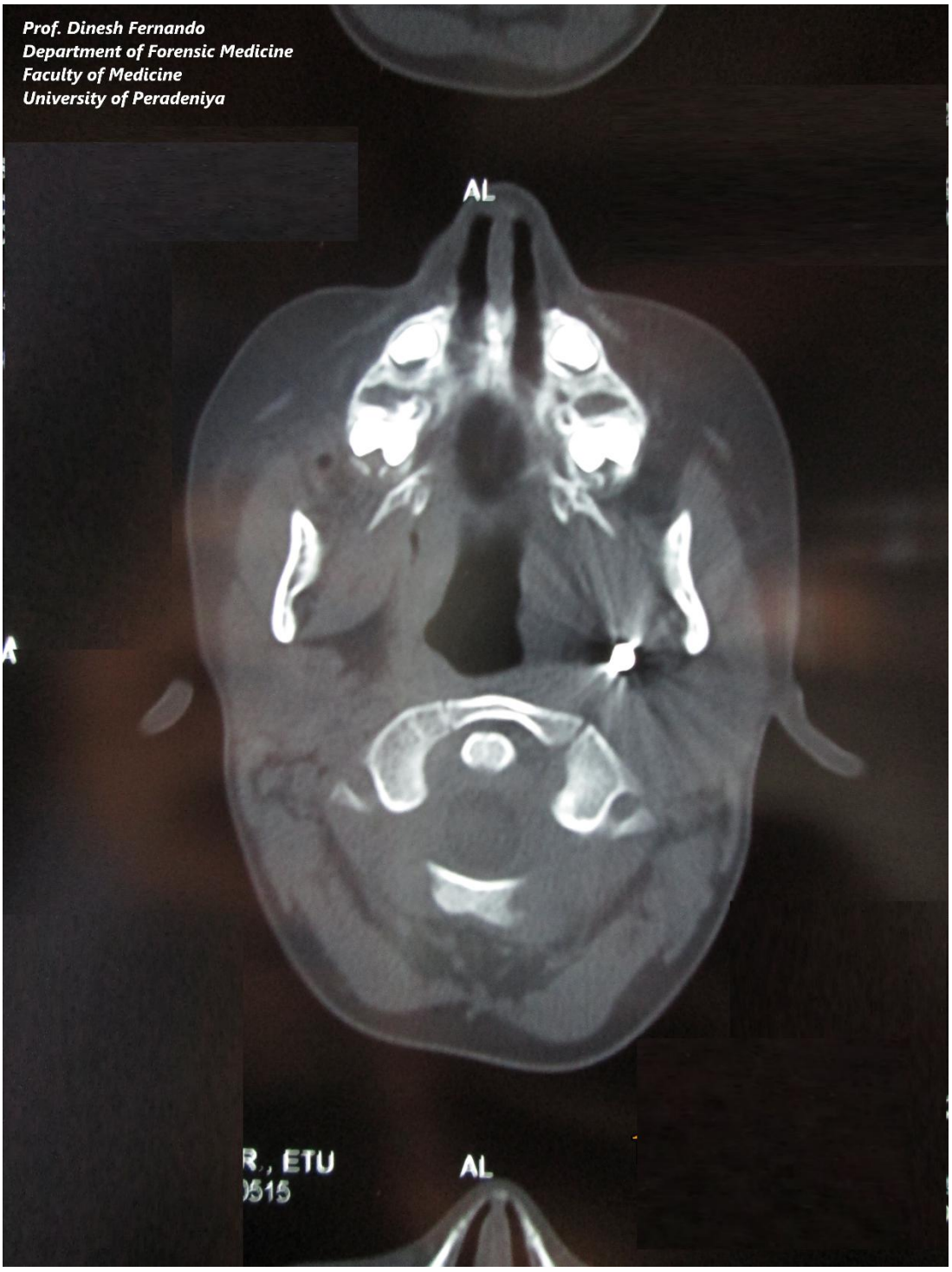


Figure 39: CT scan of the skull demonstrating a hyperdense object in the left pharyngeal space.

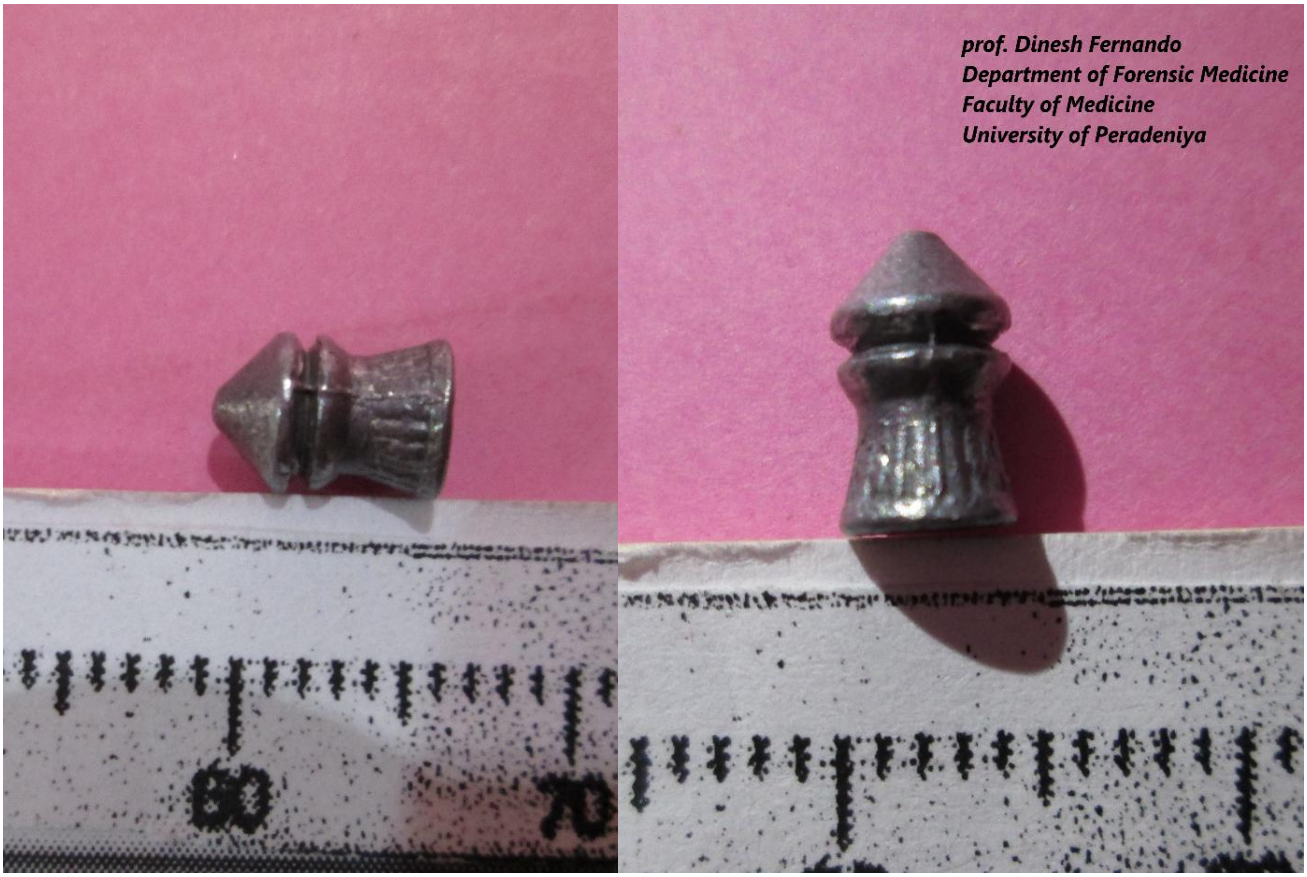


Figure 40:Slightly distorted air gun pellet.

Figure 41: (a) The air gun used in the incident (b) make, model and calibre on the barrel.