Torture, 2025, 35(1), 59-66
https://doi.org/10.7146/torture.v35i1.156425 *Research Paper*

Ballistic projectile maxillofacial injuries in the context of human rights violations in Chile: a 5-case series

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Key points of interest:

- Despite international guidelines on the use of riot control weapons, ballistic projectile injuries frequently affect the craniofacial region.
- Damage caused by such projectiles, particularly in the maxillofacial area, extends beyond physical harm, often resulting in aesthetic and psychological consequences.
- The potential risk of heavy metal poisoning should be considered when evaluating whether to retain embedded projectiles.

Abstract

Introduction: On 18 October 2019, Chile experienced a wave of civil protests driven by social demands, which continued for several months across the country. The response by law enforcement and armed forces resulted in injuries caused by ballistic projectiles, some of which affected the maxillofacial region. *Materials and Methods:* This is a multiple case report study analysing five forensic reports prepared by forensic odontologists from the Medicolegal Service of the Valparaíso region, Chile. *Results:* Various injuries were observed, including fractured teeth, scars, paraesthesia, and embedded ballistic projectiles. *Discussion:* The injuries are often permanent, compromising functionality and causing aesthetic and functional damage. Lead poisoning should be considered in cases where projectiles remain lodged in soft tissues.

Keywords: Forensic dentistry, human rights, projectile, less-lethal weapon, lead poisoning.

Introduction

On October 18, 2019, various cities in Chile witnessed numerous citizen protests motivated by social demands related to healthcare, education, social security, and other issues (Sferrazza Taibi et al., 2021). During these protests, the Armed Forces and law enforcement employed various weapons, including "riot shotguns" that fire rubber pellets (kinetic impact projectiles - KIPs) (Sferrazza Taibi et al., 2021). These projectiles are labelled as "non-lethal" or "less-lethal" munitions and are primarily intended to incapacitate or disperse protesters by inflicting pain through blunt-force trauma. However, there is substantial evidence that these munitions can cause more than just blunt injuries, potentially leading to mutilation or even death (Velásquez Valenzuela et al., 2021).

Although there is no globally accepted definition regarding these weapons, Chilean protocols authorise using less-lethal kinetic impact projectiles (Reynhout, 2020). In a document requested by the Regional Prosecutor's Office of Valparaíso,

the General Secretariat of Carabineros (Secretaría General de Carabineros, 2020) reported the weapons used starting October 18, 2019. The document specifies that TEC Harseim primarily produced the non-lethal ammunition used in 12-gauge shotguns. In contrast, the Civilian Police (Policia de Investigaciones-PDI) used cartridges produced by Companhia Brasileira de Cartuchos (CBC) (Reynhout, 2020).

As a result of this "social outbreak," numerous human rights violations were reported. According to the National Institute of Human Rights (INDH), between October 17, 2019, and February 18, 2020, a total of 1,681 pellet injuries were recorded (nearly 60% of reported injuries), including 445 cases of ocular injuries (INDH, 2020). A 2021 study (Rodríguez et al., 2020) investigated cases of ocular trauma between October 18 and November 30, 2019, documenting 259 cases, of which 182 were associated with KIPs (Ortega et al., 2022; Rodríguez et al., 2020). Similar incidents have been recorded in other Latin American regions and European countries, highlighting that riot control weapons or "less-lethal weapons" may not only cause minor injuries.

The use of these weapons must also adhere to established guidelines. According to the United Nations Human Rights Guidance on Less-Lethal Weapons (OHCR, 2021), KIPs should only be used on the lower abdomen or legs. They should not be aimed at the head or face, as such impacts can cause death or serious injuries. A report by the uniformed police (Casanova, 2020) confirms these UN recommendations, stating that these weapons should be used from 30 meters. However, forensic analysis may have underestimated the risk. Less-lethal pellets can be dangerous when fired at distances where their dispersion cannot be controlled effectively. Additionally, shotgun shooters do not have complete control over pellet spread, a problem that worsens over longer distances (Reynhout, 2020).

This paradox and the recommendations from various institutions highlight the fragile nature of the maxillofacial region. The structures in this area are thinner than those in other parts of the body and house vital organs, while also having aesthetic significance (Ortega et al., 2022). Injuries caused by less-lethal weapons in the maxillofacial region not only affect soft tissues or cause minor injuries but can also impact hard tissues, resulting in fractures or the lodging of projectiles within these structures. Such injuries require more complex treatment to restore the patient's health fully (Ortega et al., 2022).

Given these circumstances, the objective of this study is to analyse, through a case report series, injuries caused by so-called non-lethal projectiles in the context of the 2019 social protests in Chile.

Materials and methods

A case report series study was conducted based on five forensic reports prepared between 2019 and 2023 by two forensic odontologists from the Medicolegal Service of the Valparaíso region (SML). For such purposes, only the information relevant to the lesion logical study was considered, excluding any other identifying data of the victims. The same institution authorised this study.

The inclusion criteria for the reviewed reports considered the following: that the dental examination was part of an expert assessment within the context of an "Istanbul Protocol"; that the events in question took place during the period of the "social uprising" in Chile between 2019 and 2020; and lastly, that the reports contained all the required information according to the formats of the Legal Medical Service or the requirements of the requesting prosecution offices.

It is important to note that the primary function of the Medico-Legal Service (Servicio Médico-Legal or SML) in Chile is to serve as an auxiliary institution supporting the work of prosecutors and courts through scientific, medical, and forensic analyses. This institution does not provide medical care for victims and only acts under the orders of prosecutors or judges.

Case reports

Table 1 summarises the relevant data of the affected individuals (age and sex), the reported events, the injuries recorded in the forensic odontologist's report and the sequelae. Teeth numbers are according to the "Fédération Dentaire Internationale" (FDI).

Discussion

The available literature regarding injuries caused by ballistic projectiles in the bucomaxillofacial region, particularly in the maxillary/mandibular area, is limited. Existing case reports predominantly focus on ocular injuries, which are often associated with more severe outcomes such as vision loss or globe rupture.

In a systematic review conducted by Sofía Ortega, a dental student at the University of Chile, compiled most case reports and studies related to "less-lethal weapons", including four types: impact projectiles (PICs), tear gas, "TASER" devices, and rubber bullet grenades. Of the 39 articles analysed in this review, only five described injuries involving PICs or other types of projectiles within the context of protests, resulting in trauma to the maxillofacial region (Amaral et al., 2017; Cohen, 1985; Gonzalez et al., 2021; Maguire et al., 2007; Scolan et al., 2012). The primary injuries reported included fractures of the mandible, maxilla, nasal bones, and orbit; soft tissue injuries, predominantly affecting the skin at the impact site; localised oedema and haematoma;

***Table 1**. Summary of Relevant Information from Forensic Odontology Report.*

Case	Sex	Age	Reported events	State agent involved (according to the report)	Observed and recorded injuries.	Sequelae of the injuries
1	Female	26 years	Projectile impact on the face and upper jaw area.	Carabinero (police officer)	- Fracture of upper central incisors (11 and 21 FDI). - Temporary crowns on teeth 11 and 21 (FDI)	-Aesthetic compromise involving anterior teeth. -Loss of vitality in two teeth (11 and 21, FDI)
2	Male	38 years	Multiple projectiles fired from approximately 2.5 meters hit the face. Some projectiles were removed at a local hospital, while others remained at the impact site.	Carabinero (police officer)	- Loss of teeth. - Presence of three facial scars. - Presence of a foreign object in the right cheek, with pain upon palpation. - Limited oral opening.	-Facial aesthetic compromise. -Potential lead poisoning. -Reduced masticatory efficiency. -Functional impairment in oral opening
3	Male	31 years	Projectile impacts during a peaceful protest, lodged in the face, neck, and shoulders.	Carabinero (police officer)	- Hyperpigmented scar on the right cheek. -Transfixing wound on right cheek. - Hypoesthesia and pain upon pressure in an area with a possible lodged projectile. - Lateral luxation of the lower molar (46 FDI).	-Facial aesthetic compromise. -Potential lead poisoning. -Continuous evaluation of tooth 46 (FDI) due to possible sequelae from dentoalveolar trauma
4	Male	26 years	Direct projectile impacts on the face and back. Visited a local hospital, where professionals decided not to extract the lodged projectile from his face.	Carabinero (police officer)	- Scar on the right cheek. - Hypoesthesia in the affected area. - There is a palpable foreign body 3 cm from the scar, with pain upon palpation.	-Facial aesthetic compromise. -Potential lead poisoning.
5	Female	24 years	Multiple projectile impacts on the face, chest, arm, and gluteus during a peaceful protest.	Carabinero (police officer)	- Scar on the left cheek, indurated upon palpation and with paraesthesia. - Reports pain with facial expressions and temperature changes	-Facial aesthetic compromise. -Activity modifications (singing)

Photographs of the analysed cases:

***Figure 1**. Case #1. Complicated tooth fractures (11 and 21 FDI) due to the direct impact of a projectile.*

***Figure 2.** Case #3. Intraoral Mandibular photography of the patient. Teeth 46 (FDI) with lateral lingual luxation.*

***Figure 3.** Case #4. Skull X-ray showing a radiopaque structure in the right cheek area, approximately 6 mm in diameter, compatible with a projectile.*

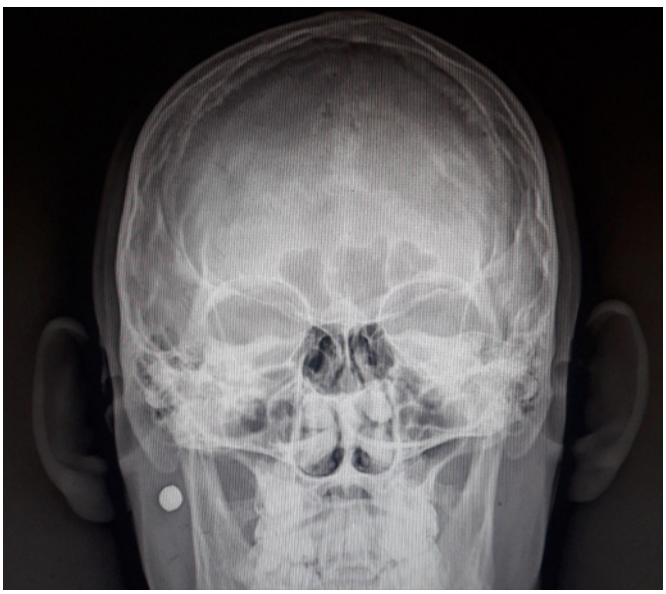
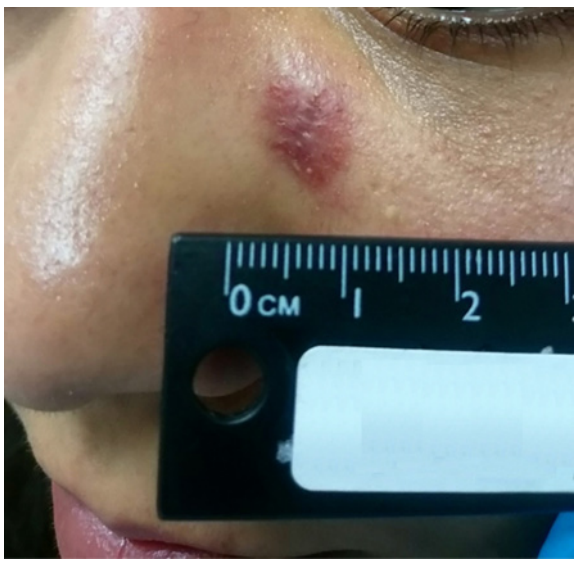
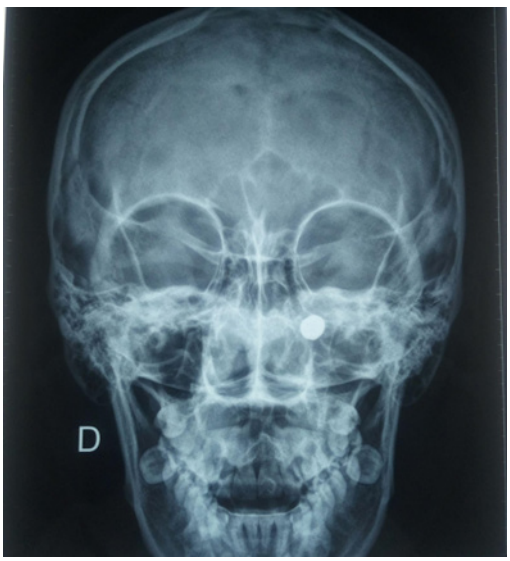


Figure 4. *Case #5. (Left) A flat scar in the genian region with an extension of 0.6 cm. (Right) Teleradiograph showing a radiopaque circular area, approximately 6 mm in diameter, located in the region adjacent to the left nasal notch and the infraorbital groove*





and paraesthesia in the affected and adjacent areas. All patients reported pain or discomfort during specific facial movements or upon palpation of the injured region.

Similar injuries, such as hematomas and oedema in the impact zone and paraesthesia, were observed in the cases presented in this study. However, it is important to note that the examinations in these cases were conducted sometime after the injuries occurred, and several patients already presented scars. The cases in Ortega's systematic review exhibited fractures of various types. However, none described injuries to teeth, in contrast to this study, which identified three cases with fractures and dental injuries.

Notably, the available literature regarding dental injuries caused by ballistic projectiles is scarce or non-existent. One possible explanation is the lower perceived significance of these injuries relative to damage to other surrounding tissues, which may be considered more complex. However, damage to dental and maxillofacial structures entails functional impairment and aesthetic and psychological consequences, negatively affecting the patient's self-esteem.

Additionally, it is worth mentioning that in two cases from the study of Ortega et al., the foreign body (the projectile) lodged in the patient's face was removed, while in the cases presented in this work, the decision was made not to remove the projectile from the affected area.

Regarding the materials used in the projectiles, a study conducted by the Department of Mechanical Engineering (DIMEC) at the University of Chile, at the request of the Ocular Trauma Unit (UTO) from the Hospital del Salvador (Santiago, Chile), confirmed that the type of projectile used by the Carabineros is composed of only 20% rubber, with the remaining 80% consisting of high-hardness minerals and/or metals such as silica, barium sulphate, and lead. These components increase the hardness and weight of the projectiles, thus amplifying the damage these pellets can inflict (Jorquera et al., 2019).

One issue highlighted by professionals who prepared the analysed reports in three of the cases presented is the potential for chronic lead poisoning due to the retention of ballistic fragments, which can pose a significant complication in firearm-induced injuries, and the removal of these fragments would mitigate this potential risk.

Lead is a soft metal that, in its inorganic form, can be toxic. This metal has been extensively studied for its long-term use, which has resulted in significant environmental contamination and increased exposure within the population, leading to various health issues (Poma, 2008; Quirgas, 2019). This exposure has often been underestimated due to the delayed onset of symptoms and/or adverse effects and a lack of awareness regarding the composition and physicochemical properties of the munitions used (Quirgas, 2019).

Lead can persist in the human body for prolonged periods, accumulating primarily in three compartments: blood, where 95% of lead is bound to erythrocytes; soft tissues such as the liver, kidneys, bone marrow, and central nervous system; and, after approximately two months of exposure, it can be deposited in the bones, where it may remain for up to 30 years. Lead may be released into the bloodstream under certain physiological conditions such as pregnancy, lactation, hyperthyroidism, or old age (Garcés & Bernardo, 2012; Poma, 2008; Quirgas, 2019).

It is known that lead interferes with calcium metabolism, as it closely resembles calcium, allowing it to mimic its functions, alter its effects on both the central and peripheral nervous systems, and affect vascular tone (Garcés & Bernardo, 2012; Quirgas, 2019). Toxic effects have also been reported in respiratory, haematological, hepatic, renal, endocrine, gastrointestinal, cardiovascular, musculoskeletal, and ocular systems (Quirgas, 2019). Chronic exposure may lead to conditions such as chronic nephropathy, anaemia, Parkinson's disease, amyotrophic lateral sclerosis, decreased fertility, and disruptions in reproductive hormone levels (Poma, 2008; Quirgas, 2019).

The mechanism by which lead is distributed throughout the body is not yet fully understood. However, it is believed that lead from the projectile casing initially diffuses in a soluble form, which is absorbed directly into the bloodstream. It then precipitates into an insoluble form, which macrophages capture and phagocytose (Garcés & Bernardo, 2012).

The development of lead poisoning depends on several factors, including the location of the projectile, the degree of fragmentation, the individual's physiological state, and the time interval between the injury and the rise in blood lead levels, which may range from a few days to several years. Although it is challenging to predict the incidence and risk of lead poisoning, the location of the projectile in synovial fluid and mobile joints has been established as a risk factor. In soft tissues, however, the retention of ballistic fragments can cause a foreign body reaction, leading to fluid cyst formation and an acute rise in blood lead levels, even long after the initial injury. These cysts have been reported in bones, connective tissue, muscles, and cartilage (Quirgas, 2019).

The recommended treatment for these cases is to eliminate the source of toxicity from the patient by removing the projectile. However, in some cases, this procedure can be complicated, as it may cause damage to other vital structures during the removal process. Therefore, the risk-benefit ratio of projectile removal must be carefully assessed, considering its location and proximity to vital organs (Garcés & Bernardo, 2012).

On a different note, an important aspect to consider in these types of injuries is their aesthetic (due to their location in the maxillofacial region) and psychological consequences due to the context of aggression. It has been observed that facial scars lead to a reduction in confidence and social activities due to feelings of shame and low self-esteem, which is also directly related to higher levels of post-traumatic stress disorder (PTSD) symptoms. It should be noted that the aesthetic evaluation is subjective, varying according to the evaluator and the affected individual, and the concept itself can differ based on factors such as the person's age, occupation, social relationships, and environment (Lagos-Tissie et al., 2021; Segundo-Jara et al., 2023).

Finally, it is crucial to highlight the importance of adhering to established protocols by law enforcement agencies regarding using less-lethal projectiles despite existing usage recommendations, which include instructions on where to aim and the optimal distance from which to fire. There is a paradox in these guidelines. As mentioned earlier, at greater distances, the force decreases, but the control over the pellets drops significantly, potentially leading to maxillofacial injuries despite following these recommendations. This is because the higher hardness of the projectiles means they do not bounce but instead penetrate the human body, potentially causing the damage described above (Universidad de Chile, 2019).

Recommendations of good practice

During emergency care:

- Provide a detailed description and evaluation of the observed injuries, which must be documented in the patient's medical record. In cases involving multiple healthcare professionals, it is recommended to assess visible external injuries and perform an intraoral examination to evaluate potential damage to internal structures or dental involvement.
- "Document the injuries": Take photographs of the observed injuries. Ideally, the consent of the patient or their legal guardian is obtained.
- Multidisciplinary evaluation: Depending on the resources available in each healthcare centre, seeking support from all relevant disciplines is crucial to ensure the best possible patient care.
- Evaluate the need for projectile extraction: This should be based on previously mentioned factors such as location, fragmentation, the patient's physiological status, and the time elapsed since the injury. Projectiles lodged in joint areas are particularly prone to lead poisoning due to dissolution in synovial fluid.

– In cases where projectiles are extracted: Store foreign bodies according to national protocols for evidence handling and "chain of custody" procedures.
– If the decision is made to leave the projectile embedded in tissue: Consider annual blood tests to measure lead levels.
– -Determine a medicolegal prognosis following current local legislation.

During medicolegal evaluation:

– Provide a detailed description and assessment of the observed injuries, supplementing information recorded by the emergency care provider and the victim's account. Photographs are usually mandatory in forensic examinations.
– Functional impairment assessment: Evaluate cases in which the victim cannot perform normal physiological activities or has suffered loss of a structural organ.
– Aesthetic assessment: Consider the presence of scars in visible areas that could affect the individual's self-perception. The assessment should also consider the impact on visible anterior teeth.
– Psychological assessment: A forensic psychological evaluation may be recommended due to the traumatic context of the assault or the resulting aesthetic or functional impairment.
– Following local regulations, apply the "Istanbul Protocol" where appropriate.
– Determine the medicolegal prognosis according to the internal regulations of each forensic service.
– The forensic evaluation may also indicate the need for additional examinations, such as imaging studies (X-rays, CT scans, or MRI) or laboratory tests, with particular emphasis on blood lead levels if a projectile remains embedded, especially in cases where the injury is of long standing (several months or years).

Conclusion

It is crucial to emphasise that, in cases where state agent violence and human rights violations are suspected, a bucomaxillofacial examination should be included as part of injury documentation, without disregarding the potential involvement of other affected structures. The limited literature on this subject may indicate an underrecognition of such injuries, which, particularly concerning dental structures, are often irreversible, with implications for biological tissue recovery as well as aesthetic and psychological harm. Furthermore, it is advisable to monitor levels of toxic components in individuals with projectiles retained in soft tissues, given the potential for long-term damage.

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Submitted 27th of March 2025
Accepted 30th of Apr 2025