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A non-powder weapon projectile uneventfully removed from the pterygopalatine fossa: A case report

Authors:
Bliźniak F DDS[1,*],
Lubecka K DDS[2],
Chęciński M DDS[2,3,4],
Karwan S DDS, MD, PhD[5],
Gola W MD[6],
Sikora M DDS, MD, PhD, DSc[3,4,7]

Affiliations:

[1] Department of Maxillofacial Surgery, Ludwik Rydygier Memorial Hospital, Osiedle Złotej Jesieni 1, 31-820 Kraków, Poland
[2] Department of Oral Surgery, Preventive Medicine Center, Komorowskiego 12, 30-106 Kraków, Poland
[3] National Medical Institute of the Ministry of Interior and Administration, Wołoska 137, 02-507 Warsaw, Poland

[4] Department of Maxillofacial Surgery, Hospital of the Ministry of Interior, Wojska Polskiego 51, 25-375 Kielce, Poland
[5] Department of Maxillofacial Surgery, Regional Specialized Children's Hospital, 10-561 Olsztyn, Poland
[6] Faculty of Medicine and Health Sciences, Jan Kochanowski University, 25-369 Kielce, Poland
[7] Department of Biochemistry and Medical Chemistry, Pomeranian Medical University, Powstańców Wielkopolskich 72, 70-111 Szczecin, Poland
[*] Corresponding author: Dr F.F Bliźniak DDS, Department of Maxillofacial Surgery, Ludwik Rydygier Memorial Hospital, Osiedle Złotej Jesieni 1, 31-820 Kraków, Poland, fblizniak@gmail.com, ORCID 0009-0009-4985-7113

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Abstract

The cases of a ballistic projectile entering the pterygopalatine fossa are rare (8 reported cases), and the procedure of removing a foreign body from this anatomical space requires an operator's experience and appropriate attention. We report the second case of a bullet from a non-powder weapon in the pterygopalatine fossa described in the English literature and the first removed by open trans-sinusal surgery. A 53-year-old male patient was shot and referred from another hospital for removal of a bullet from the pterygopalatine fossa. The patient had a craniofacial CT scan and was in good general condition. The foreign body was trans-sinusally non-endoscopically removed. The experience, knowledge and manual dexterity of the operator allowed avoiding iatrogenic complications such as intraoperative bleeding and nerve injury. The basis for a successful operation was good diagnostic, including radiological diagnostic consisting of performing a cranio-facial CT scan.

Keywords: case report; gunshot wounds; penetrating head injuries; maxillary sinus; projectile

Introduction

Non-powder weapons (NPWs) are a group of weapons that operate using compressed gasses, electricity, or a spring system [1, 2]. Illegal modifications of NPWs increase their power and make them a real threat to the health and life of a potential gunshot victim [2–4]. A gunshot wound from NPW may lead to bruises, cuts, skin perforations, further tissue disruption, bone fractures, damage to internal organs, deformation of facial tissues, or partial disability [2, 5-8]. The maxillary sinuses are the largest ones in the group of paranasal sinuses, i.e. pneumatic spaces of the facial skeleton, which also include the frontal, sphenoid and ethmoid sinuses [9]. The posterior wall of maxillary sinus is called the maxillary tuberosity and is separated from the lateral wall by the zygomatic-alveolar crest. Behind it are the pterygopalatine fossa and the infratemporal fossa. In an extremely unfavorable situation, the bullet from the NPW may penetrate not only the anterior but also the posterior wall of the maxillary sinus and enter the pterygopalatine fossa [10].
To check whether cases of bullet penetration into the pterygopalatine fossa have already been reported, Bielefeld Academic Search Engine (BASE) and PubMed engine were used. The search was carried out on July 16, 2024 using the following query: "(airgun OR nonpowder OR npw OR bullet OR projectile OR pellet OR bearing OR bb) AND (pterygopalatine OR pterygopalatina) AND case". BASE and PubMed displayed 12 and 5 records, respectively. Of these, 5 were papers reporting a total of 7 cases of patients with bullets trapped in the pterygopalatine fossa [10–14]. Of these, 5 were presented in 3 articles in English. Only one of these involved a bullet from the NPW, but unlike our case, endoscopic removal was performed. Our report is therefore the second case of a bullet from the NPW in the pterygopalatine fossa described in the English literature and the first removed by open trans-sinusal surgery. This paper was prepared in accordance with the CARE guidelines for clinical case reports [15].

Case report

A 53-year-old patient was urgently admitted to the maxillofacial ward after being shot 2 days earlier. The patient had previously been treated in another hospital, where a computed tomography (CT scan) of the craniofacial area was performed, and another pellet was removed from the right forearm. The patient was admitted in good general condition. At that time, the patient was under chronic treatment only for hypertension and under the supervision of a cardiology clinic. The patient stayed

permanently in a nursing home, but had contact with his family. The patient was shot with an airgun near his residence for unspecified reasons. Upon admission, the patient complained of pain in the left maxillary area.

The physical examination revealed facial asymmetry, swelling of the left infraorbital area, and a descending periorbital hematoma of the left eye. There was also a visible round wound on the left cheek, which was an entry hole. The area around the gunshot wound was tender and the patient felt pain during palpation. No pathological changes were found on the mucosa intraorally. There were also no symptoms related to gunshot wounds, either in the oral cavity proper or in the oral vestibule.

The patient was given a standard form to complete regarding his health condition. Among the diseases, the patient mentioned hypertension and mood changes that may correspond to neurosis or depression. The patient also mentioned regularly used medications, including Metocard (metoprolol) and Prestarium (perindopril). In addition, the patient mentioned episodes of loss of consciousness and tendency to excessive bleeding (but undiagnosed).

The patient underwent necessary tests to qualify him for the procedure and to minimize the risk of post-procedure complications. An electrocardiogram was performed at rest. It did not reveal any irregularities. The blood pressure was 140/80 mmHg, which is an acceptable value for a person suffering from hypertension and under the supervision of a cardiology clinic [16]. The patient also underwent serological testing, which revealed blood group A RhD positive. Blood counts were all within normal limits. Coagulation also showed no abnormalities apart from a slightly decreased APTT of 19.30 (reference range from 21.30 to 31.90).

Biochemical tests, in turn, showed only increased glucose levels in the patient's blood. It was 136 mg/dL (reference range is 60 to 100 md/dL).

A typical diagnostic challenge when assessing the content of the maxillary sinus after an injury penetrating its lumen results from radiological shading corresponding to the blood clot. The location of the hyperdense area corresponding to fluid blood or clots results from the position of the head during exposure. In the case of classic fan beam CT scan, the patient typically lies down during the examination [17]. This was also the case in the described case. The blood was displaced towards the posterior wall of the sinus and made it difficult to assess the fracture and the exact location of the projectile. However, the radiological image undoubtedly indicated a fracture of the anterior and posterior walls of the maxillary sinus and the presence of a shading foreign body in the pterygopalatine fossa (Figures 1-5). Therefore, there was no need to implement differential diagnosis.

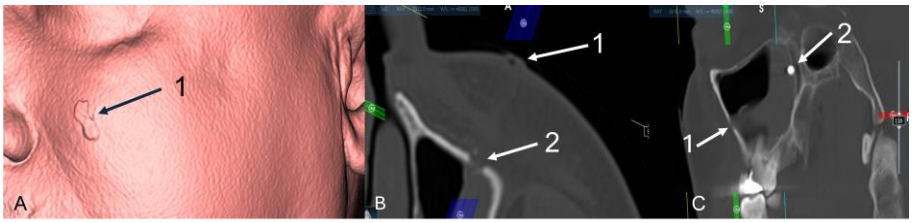

Fig. 1. Visualization of the entry wound based on CT scan. A. 3D visualization of external soft tissues of the left cheek. 1: entry point at the skin. B. Axial view. Trajectory of the bullet. 1: entry point at the skin. 2: entry point at the anterior wall of the left maxillary sinus. C. Sagittal view. 1: entry point at the anterior wall of the left maxillary sinus. 2: position of the bullet in the posterior wall of the left maxillary sinus.

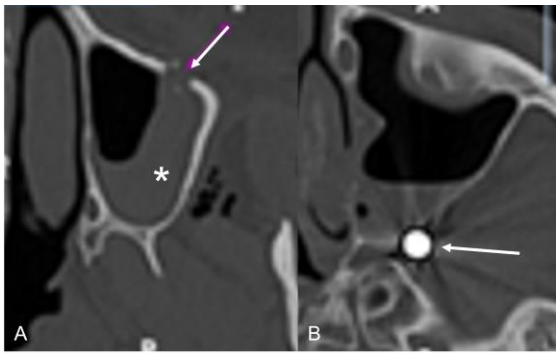

Fig. 2. Trajectory of the bullet on CT scan. A. Axial view; arrow: entry point at the anterior wall of the left maxillary sinus. * Blood clot in the left maxilary sinus. B. Axial view; arrow: the bullet is positionned partially in the posterior wall of the left maxilary sinus and in the left pterygopalatine fossa.

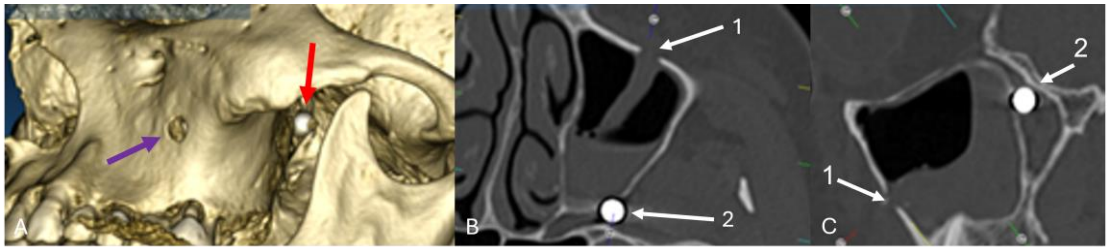

Fig. 3. Trajectory of the bullet on CT scan. A. 3D reconstruction of the left maxillary sinus. Violet arrow: entry point. Red arrow: bullet in between the posterior wall of the left maxillary sinus and the left pterygopalatine fossa. B. Axial view. 1: entry point at the anterior wall of the left maxilllary sinus. 2: bullet in between the posterior wall of the left maxillary sinus and the pterygopalatine fossa. C. Sagittal view. 1: entry point at the anterior wall of the left maxilllary sinus. 2. Major part of the bullet is situated in the left pterygopalatine fossa.

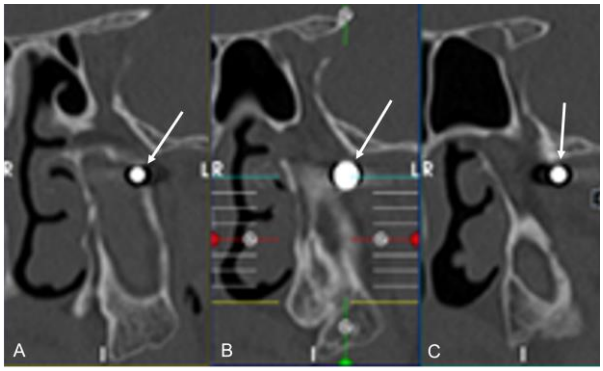

Fig. 4. Position of the bullet in the left ptreygopalatine fossa on coronal images of CT scan. A. Arrow: anterior part of the bullet is situated in the posterior wall of the left maxillary sinus. B. Arrow: major part of the bullet is positionned immediately behind the posterior wall of left maxillary sinus in the left pterypalatine fossa. C. Arrow: minor part of the bullet is situated deeper in the left pterygopalatine fossa.

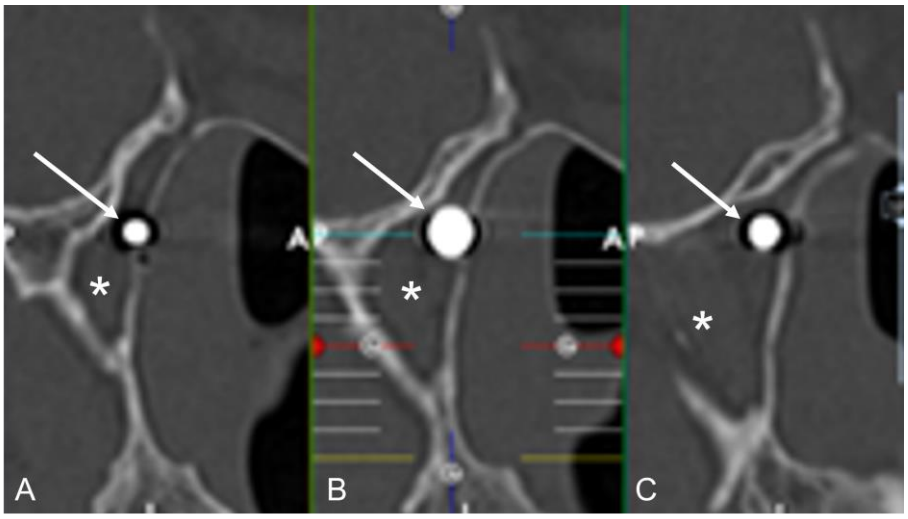

Fig. 5. Position of the bullet in the *left pterygopalatine fossa on axial images of CT scan. A. Upper part of the bullet is trapped in the posterior wall of the left maxillary sinus. B. Major part of the bullet is situated close to the posterior wall of the left maxillary sinus. C. Inferior part of the bullet is situated deeper in the left pterygopalatine fossa.

The pterygopalatine fossa is an important anatomical structure in the shape of an inverted three-sided pyramid located between the maxilla and the sphenoid bone [18]. Its contents include the pterygopalatine ganglion (Meckel's ganglion), the maxillary nerve and the maxillary artery, specifically a part of its second section and the third section [18]. Both the bullet in the pterygopalatine fossa and a careless attempt to extract it from there may cause bleeding that would be difficult to control [19]. Moreover, there may be an injury to the mentioned ganglion, which may potentially manifest itself, among others, in impaired sensation in the mucous membrane of the anterior part of the palate to the line connecting the canines. The pterygopalatine fossa is located in the immediate vicinity of, among others, the inferior orbital fissure and the infratemporal fossa, which requires additional vigilance of the operator performing the procedure in this area [20].

The patient's pharmacological treatment included the administration of the following drugs: Tarsime (cefuroxime), IPP (pantoprazole), Acetaminophen (paracetamol), Ketonal (ketoprofen), Sulfarinol (sulfathiazole), ACC (acetylcysteine), Amertil (cetirizine), Prestarium (perindopril), Metocard (metoprolol), and Clexane(enoxaparin sodium).

The procedure to remove the bullet from the pterygopalatine fossa was performed with the patient under general anesthesia. Intubation was performed through the mouth with the endotracheal tube placed on the right side. Local infiltration

anesthesia was also used to complement general anesthesia. Its use allowed for decreasing postoperative pain and improving hemorrhage control. Then, a mucoperiosteal flap was prepared from a trapezoidal incision in the upper fold, revealing the anterior wall of the left maxillary sinus. The left infraorbital nerve and the bony framework of the piriform foramen on the left side were localized. A round bone defect was found in the mentioned anterior wall of the sinus, which was the entry hole. Then, using a piezo surgery bone saw, a bone window was cut out in the anterior wall of the left maxillary sinus and the cut bone plate was removed. As several dozen hours had passed since the injury and the patient had spent most of that time in a lying position, there was a lot of mucous and bloody secretion in the sinus, which covered the posterior wall of the sinus, so the secretion was aspirated. Then the inside of the left maxillary sinus was examined. A spherical metallic foreign body was found stuck in the posterior wall of the maxillary sinus and in the anterior part of the left pterygopalatine fossa. A small amount of bone surrounding this foreign body was removed with due care using a bone burr. The bullet was then removed. Revision of the pterygopalatine fossa did not reveal any damaged anatomical structures within it. There was no intraprocedural hemorrhage. The bone plate in the anterior wall of the left maxillary sinus was returned to its original place, and the mucoperiosteal flap was sewn using Polysorb 4-0 resorbable sutures.

After the procedure, the patient received recommendations that included proper oral hygiene and avoiding injuries to the operated area. In addition, he was to come back to the maxillofacial surgery clinic four weeks after the surgery for a check-up after setting an appointment by phone on the day of discharge from the hospital. The patient was also recommended to follow a pulp diet and to continue treatment of concomitant chronic diseases under the supervision of appropriate specialist. The patient was also advised to check his fasting blood glucose 7-10 days after the procedure at a primary health care facility. The following medications were also recommended: Xorimax (cefuroxime) 500 mg, 2 times a day, 1 tablet (10 tablets); Ketonal (ketoprofen) 50 mg, 1 tablet once a day in case of pain (30 tablets); IPP20 (pantoprazole) 1 tablet once a day (28 tablets); Jovesto (desloratadine) 5 mg, 1 tablet once a day, in the evening (10 tablets); Sulfarinol (sulfathiazole) drops, 3 times a day; ACC (acetylcysteine) 600 mg, 2 times a day, 1 tablet in the morning and at noon; and the patient's own medications as before.

Postoperative check-up in the hospital clinic did not reveal any irregularities in the healing of the operated area. The stitches were removed, and the patient was advised to massage the scar on his left cheek, which was already barely visible at the time of the check-up.

Discussion

NWPs projectiles entrapped in the pterygopalatine fossa are rare [10–14]. This is due to the numerous anatomical structures that the bullet must perforate to lodge in the pterygopalatine fossa. These include the skin and subcutaneous tissue, the anterior wall of the maxillary sinus, the mucous membrane of the maxillary sinus and the posterior wall of the maxillary sinus [7, 9]. Therefore, the bullet entering the pterygopalatine fossa must have appropriate momentum or be fired at close range into the victim's face.

There are several threats to the patient's health and life related to the bullet entering the pterygopalatine fossa. One of the main ones is difficult or even impossible to control hemorrhage associated with interruption of the continuity of the maxillary artery located within this fossa [19]. Access to this artery is limited, which makes effective and quick surgical intervention difficult, so a gunshot victim may quickly exsanguinate [26]. Hemorrhage from the maxillary artery may also be an iatrogenic complication of attempting to remove a foreign body from the lumen of the pterygopalatine fossa [11]. This procedure therefore requires considerable experience and skill of the operator, most often a maxillofacial surgeon.

The surgical approach described in this case is a proven approach supported by scientific evidence [21]. It is called the Caldwell-Luc approach [21]. However, one must pay attention to the course of the superior posterior alveolar artery. It is good to monitor it radiologically [22]. Bleeding resulting from an accidental interruption of the continuity of this vessel may significantly impede the smooth performance of the procedure. Three-dimensional diagnostic is currently the basis for surgical procedures in the craniofacial area [22, 23]. It provides very good spatial orientation, helps to plan the procedure and reduces the risk of intra- and post-operative complications [23]. Access to the lumen of the maxillary sinus through its anterior wall is convenient, relatively safe and provides the surgeon with a proper vision into the surgical field [21]. The latter is required to minimize iatrogenic complications.

An alternative surgical approach in the discussed case could be an endoscopic attempt to remove the foreign body from the pterygopalatine fossa, but this is a more time-consuming procedure and does not necessarily provide the surgeon with good in-sight into the surgical field [24]. It is also a more expensive method, although nowadays more and more surgical departments are equipped with endoscopes [25].

From patient's perspective the patient did not report any irregularities or reservations regarding the treatment he was offered and performed.

The entrapment of a projectile in the pterygopalatine fossa is exceptional. In the described case, it entered through the skin of the cheek and the anterior and posterior walls of the maxillary sinus. Surgical removal was performed trans-sinusally. There were no complications, but due to the richness of the contents of the pterygopalatine fossa, they could have been severe or even lethal.

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- **Informed consent**: There was no need for the informed consent for this case report as all the images were anonymized and no private data were provided allowing the patient's identification

Authors contribution:

Author	Contributor role
Bliźniak Filip	Conceptualization, Methodolody, Formal analysis, Visualization, Writing original draft preparation, Writing review and editing
Lubecka Karolina	Methodology, Software, Formal analysis, Writing original draft preparation, Writing review and editing
Chęciński Maciej	Conceptualization, Investigation, Validation, Project administration, Writing original draft preparation, Writing review and editing
Karwan Sławomir	Visualization, Validation, Writing review and editing
Gola Wojciech	Software, Data curation, Writing review and editing
Sikora Maciej	Project administration, Funding aquisition, Resources, Validation, Supervision, Writing review and editing

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