REVIEW ARTICLE

Barotrauma in Oro-facial Region

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ABSTRACT

This paper provides a review of the literature concerning the etiology and manifestations of barodontalgia, as well as important clinical considerations for its management. Dental barotrauma is a condition in which barometric pressure changes in the external environment cause damage to the dentition. The problem can occur due to a miniature void within a filled tooth. The voids may be due to faulty restorations, fractured tooth, dental caries, pulpitis, pulp necrosis, apical periodontitis, periodontal pockets, impacted teeth, and mucous retention cysts, maxillary sinus pathology or even due to secondary caries under permanent restoration. According to Boyle's law, when the external pressure rises or falls the trapped air within the void will attempt to expand or contract. Due to the change in the pressure inside the tooth structure can cause pain, or rarely fracturing of the tooth structure. Typically this is seen in scuba divers or aviators who experience pressure changes in the course of their activity. Identifying the pain during a pressure change is a diagnostic indicator for the clinician. Treatment involves removing the void space by carefully replacing the offending restoration, repeating the endodontic treatment or removing the tooth.

KEYWORDS: Barodontalgia, Aviation Dentistry, Fracture, Restoration, Trauma

INTRODUCTION

Not long after the innovation of flight toward the start of the twentieth century in-flight physiologic and pathologic phenomena started to be reported.[1] With the introduction of the self-contained under-water breathing apparatus (SCUBA), appearances, created by barometrical weight changes were portrayed in the relationship with plunging. The phenomena which incorporate barometric weight affected dental agony, tooth break, reclamation crack, decreased retention of the rebuilding and crown, consequences for paranasal air sinuses and second rate alveolar nerve paresthesia, called dental barotrauma.[1] Dental barotrauma is a condition where barometric pressure changes in the external environment reason harm to the dentition.[2]

For the most part, this is seen in aviators or pilots who experience pressure changes in their everyday action.

BOYLE'S LAW AND BAROTRAUMA

According to Boyle's law, the volume of gas at a constant temperature varies inversely with the surrounding pressure.[1]

The gas pressure-volume alters inside the body's rigid cavities, associated with the changing atmospheric pressure, can cause inflammation or other adverse effects, known as barotrauma.[3]

In the orofacial region, barotrauma is manifested either as facial barotrauma or dental barotrauma.[1]

TYPES OF DENTAL INJURIES DUE TO BAROTRAUMA

Dental Pain: Barodontalgia, commonly known as tooth squeeze and some time ago known as aerodontalgia, is an agony in tooth brought on by a change in barometrical pressure. The pain typically stops at ground level.[4]

The most common victims are SCUBA divers (because in deep dives pressures can increase by the several atmosphere) and military pilots (because of rapid changes). In pilots, barodontalgia may be severe enough to cause premature cessation of flights.[5] The greater part of the basic oral pathologies have been accounted for as could reasonably be expected sources of barodontalgia: dental caries, defective tooth restoration, pulpitis, pulp necrosis, periodontitis, periodontal pockets, impacted teeth, and mucous retention cysts.[3] One exception is barodontalgia showed as referred pain from barosinusitis.[3] This condition is created as of pressure changes instead of pressure related flare-up of previous conditions.[4] In a current study, 8.2% of 331 Israeli Air Force aircrews reported no less than one scene of barodontalgia. The rate of barodontalgia was around 1 case every 100 flight-years in the Israeli Air Force.[1]

Tooth Fracture: Calder and Ramsey gave an account of an in-vitro decompression concentrate on extracted teeth. Tooth structure fractures are more noteworthy than restorations efforts breakage since the tooth may be irreversibly harmed (Fig 1 A,B). Authors applied a pressure drop of 1035 KPa to ground atmosphere pressure within 2 minutes on 86 removed teeth.[6]

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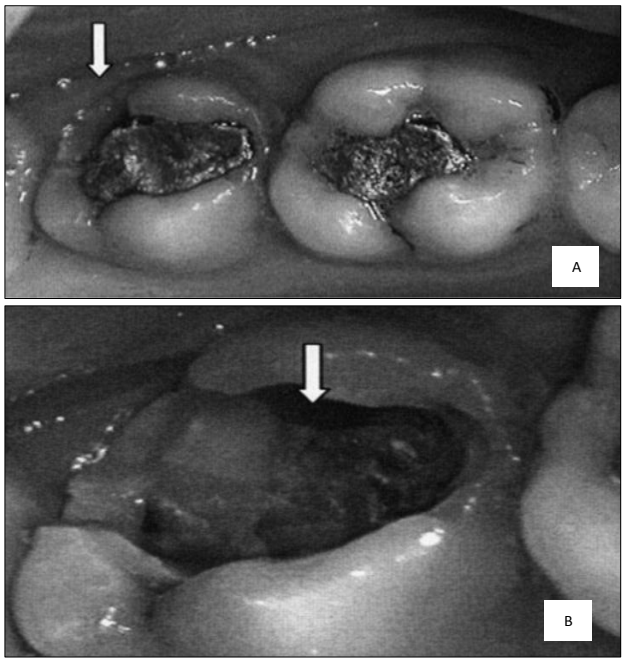

Fig 1(A, B): Tooth fracture

Five of the studied teeth were damaged. All the damaged teeth had either low quality amalgam restorations or inappropriate clearance between the tooth and amalgam restoration.[6] The 81 non-damaged teeth included unrestored teeth with carious lesions. The authors concluded that the primary predisposing component for tooth crack was leaking restoration instead of caries.[6] They have coined the expression "odontecrexis" (Greek for tooth blast) to explain this physical disruption of teeth with leaking restorations because of barometric pressure change.[6]

Restoration Fracture: This usually happens when a void or carious part present within restoration and tooth structure. Air entrapped in that void gets expanded or compressed due to change of pressure or temperature.[7]

A 40-year-old man had faulty restorations in three teeth while he was SCUBA diving at a depth of 35 meters. There was carious dentin inside the affected teeth. The affected teeth was treated endodontically and prosthetic rehabilitation was done.[7]

Inproper restorations and inappropriate selection of dental materials may predispose patients to barotrauma. To prevent barotrauma-related damages on the teeth, it is important to maintain proper restorations and avoid voids underneath the restoration (Fig. 2-5).[7]

Fig 2: Restoration fracture

Barotrauma typically happens when decayed dentin is present under the restoration of a tooth structure. Air captured in that void gets extended or packed because of progress of pressure or temperature.[7]

Fig 3: Restoration fracture

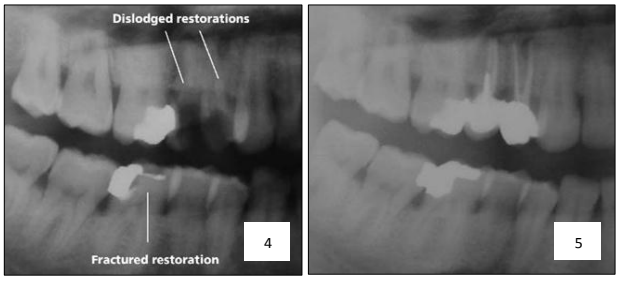

Fig 4,5: Restoration fracture and its radiographs

Reduced Retention of The Restoration And Crown: Because of the progress of environmental pressure microleakage may happen that could display clinically as barodontalgia before crown dislodgment.[8] Expanded environmental pressure causes a pressure of the gas, and it is conceivable that this physicochemical event could likewise influence the maintenance of settled prostheses to teeth (Fig. 6).[8]

In an in vitro study, Musajo et al. found that the bond quality of zinc phosphate cement were essentially reduced after pressure cycling from 0 to 3 atmospheres.[8]

Fig 6: Crown dislodged

Retention of Removable Partial Denture: Less barometric pressure can disable the retention of removable complete dentures. Then again, though environmental pressure is a positive factor for the retention of maxillary dentures, it is assumed to be just a fractional part in mandibular denture retention, in which a 70% lessening in pressure created a 50% loss in retention.[10]

Effects On Paranasal Air Sinuses: Disequilibrium of pressures in the paranasal sinuses is caused by blockage of sinus ostia from tissue overgrowth, such as a polyp, edema or mucus. The principle symptom is pain, and the release of bloody mucus on relief of the pressure differential (Fig.7).[11]

The maxillary sinus is the commonest site for barotrauma; however, the frontal, ethmoidal and sphenoidal sinuses may also be affected. More than one sinus may be affected in any one injury.[11]

Maxillary sinus squeeze gives rise to pain which may seem to originate inside the teeth of the upper jaw.

The maxillary division of fifth cranial nerve might be damaged by over-pressure. This may lead to loss of sensation over one side of the upper part of the face.[11]

Frontal sinus squeeze gives pain which may be very severe and intractable. Sphenoid sinus squeeze pain is sometimes referred to the vertex of the skull.[11]

Drainage of hemorrhagic fluid through the right sphenoid sinus ostium was revealed by the endoscopic view of the right nasal cavity under rigid nasal endoscopy.

The ethmoid sinus is separated from the cranial fossa by the thin cribriform plate. Air may penetrate into the cranium from an over pressurised sinus (pneumocephalus).[12] Air may penetrate the subarachnoid space through sinus barotrauma.[12]

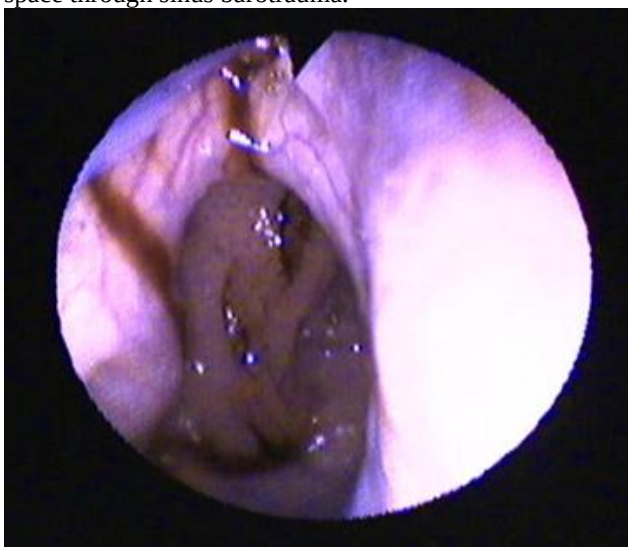

Fig 7: Changes in paranasal air sinuses due to pressure

Inferior Alveolar Nerve Paraesthesia: A 42-year-old otherwise healthy man reported a sensory loss in the left lower lip during commercial airline flights. This symptom did not occur on every airplane; rather, the loss of sensation seemed to appear selectively on some airliners. A careful clinical examination was performed. Tooth number 37 was missing. No mucosal lesions were detected, and the patient did not show any nervous system impairment on neurological examination. A panoramic radiograph showed a radiolucent area of about 3.0 X 1.5 cm in the left half of the mandible, with well defined osteosclerotic margins, in close relation to tooth number 36, a previously endodontically treated tooth which presented a periapical radiolucency around the mesial root. The lesion extended close to the alveolar canal, which appeared dislocated downward (Fig. 8-10).[13]

A CT scan was performed to visualize its exact location. The lesion's mesiodistal diameter was 3 cm, its cephalocaudal dimension was 16 mm, and it had determined the resorption of the mandibular lingual cortex, which was reduced to 1 mm.[13]

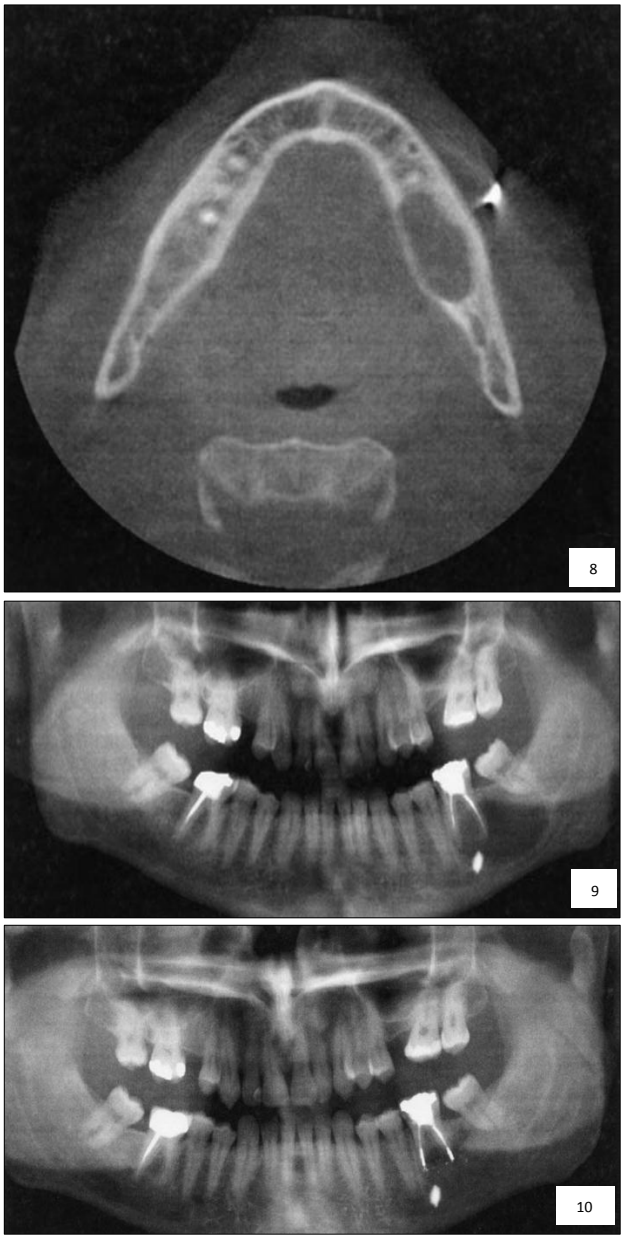

Fig 8,9,10: Radiographs of surgical wound healing

The surgical removal of the lesion was performed by cystectomy. During the same surgery, an apicoectomy was performed on tooth number 36. The final diagnosis after pathologic examination was residual cyst, following extraction of tooth number 37.[13]

The surgical wound healed normally, and the symptoms were never experienced again on airplane journeys.[13]

BLAST INDUCED DENTAL BAROTRAUMA: Bomb explosions have the potential to inflict multi-system, life-threatening injuries on many people simultaneously.[14] The pattern of injury produced can be complex, unpredictable and diagnostically challenging. Such injuries, which were previously usually seen in a military setting, are now becoming more familiar in the civilian world.[15] The simultaneous arrival of multiple critically ill casualties, as well as many with non-critical injuries, can overwhelm a medical facility. Therefore mass casualty terrorist incident planning needs to encompass this, and ensure that radiology services do not become a bottleneck to patient flow.[16]

Bomb blast injuries have been classified into four categories. Patients may be affected by one or more categories.[17]

Primary Injuries: Primary blast injuries are due to the initial very high pressure blast wave impacting especially at air-liquid interfaces on both solid and air-filled structures (barotrauma). The primary shock wave spreads radially at the speed of sound. In air it dissipates rapidly in proportion to the cube of the distance from the blast centre whereas in water it is transmitted more powerfully, more rapidly and over a longer distance. The degree of tissue injury is directly related to the magnitude and duration of the peak pressure as well as the proximity of the victim to the blast.An explosive blast and explosive decompression creates a pressure wave that can induce barotrauma. Facial injury and fractures are common, due to both flying debris and direct blunt trauma.A disrupted maxillary sinus is commonly seen as a focal point in facial fractures from blast injury (Fig. 11).[16]

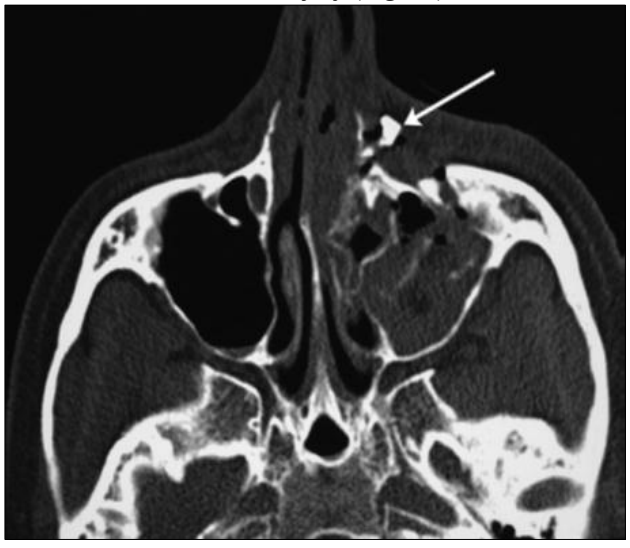

Fig 11: Radiograph of facial fracture in blast injury

Several systems are prone to primary blast injuries. They are: the inner ear and eardrum, the limbs and earlobes (both traumatically amputated), the lungs (socalled blast lung injury), and rarely, the gastrointestinal tract. Of those with a primary blast lung injury, many die immediately due to a massive cerebral or coronary air embolism. A small group of those with primary blast lung survive but may later die due to progressive pulmonary insufficiency. Proximity to a blast is probably more important than the strength of the blast. Close proximity that does not result in immediate death can result in traumatic amputation of limbs and ear lobes, hence these are indicators that the victim was close to the blast centre. Those who are at a distance greater than 6 metres from the bomb will probably not experience substantial blast injury. Position of the victim in relation to the bomb, including angle and height of the victim in relation to the centre of the explosive device, are also important in determining extent of injury.[16]

Secondary, Tertiary and Quaternary Injuries:Secondary blast injuries are caused by flying debris and bomb fragments causing penetrating trauma. Tertiary injuries occur when individuals are thrown by a major ‘‘blast wind’’, a longer phase of negative pressure causing blunt and penetrating trauma. Quaternary injuries include all other injuries and illnesses, e.g., burns, smoke inhalation, and the exacerbation of existing conditions (Fig. 12).[16]

Overall, it is secondary and tertiary effects that predominate amongst bomb survivors as many die from primary blast effects at the scene. Injuries in survivors may be due to a combination of effects; for example, traumatic limb amputation arises due to primary and tertiary effects. The primary blast shearing wave runs along bone and causes a comminuted limb fracture, the limb subsequently flails in the tertiary blast wind, which completes amputation of the residual intact soft tissue structures.

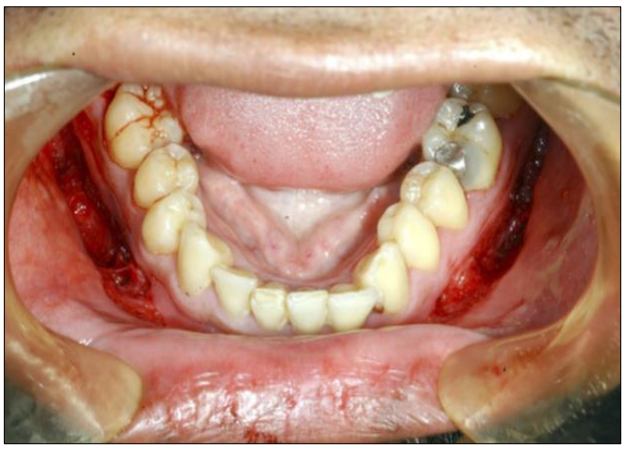

Fig 12: Tear of mucobuccal fold in blast injury

An unusual ‘blast’ injury: A 42-year-old man was blown 4–5m by the explosion of a truck tyre that he had cut with a knife. He complained of a small amount of blood on his gums from lacerations 4–5 cm long at the base of the gums bilaterally. The injuries were probably caused by the ‘blast’ of the exploding tyre filling his

mouth and forcing his cheek away from the gums. Authors explored the wounds and found full-thickness mucosal lacerations involving the muscle, which were sutured.[17]

Injuries caused by exploding tyres can be been classified as direct injuries caused by metal rim fragments, and barotrauma as a result of high pressures damaging tissues, often in the head and face. A range of injuries caused by fragments of the rim have been documented including maxillofacial injuries, long bone fractures and catastrophic head injury. Barotrauma can cause tympanic perforation and eye injury, as well as the more severe documented injuries including oesophageal rupture and pnuemomediastinum.[17]

AVOIDANCE AND TREATMENT

Barotrauma can be avoided by eliminating any pressure differences acting on the tissue or organ by equalizing the pressure.[3]

Discipline	Principles
Prevention	• Balanced diet with regular meals, avoidance of high-energy snacks • Timely oral self-care
Periodic examination	• Vitality test to extensively restored teeth •Special attention to defective restorations, restorations with poor retention, and secondary caries lesions • Rule out bruxism
Restorative treatment	•Removal of all carious tissue and placement of protective cavity liner before restoring
Endodontics	• Avoidance of direct pulp capping • Reinforced temporary restoration
Prosthodontics	• Enhanced retention • Resin cement should be used to lute crowns
Oral surgery	• Rule out oro-antral communication

CONCLUSION

Although dental barotrauma is currently quite rare, a clinician should be familiar with this condition. Clinicians should be prepared to take preventive measures as well as periodically examine patients who fly planes or SCUBA dive. Leaking restorations or secondary caries lesions must also be taken into account. In addition, clinicians must beaware of the possible influence of pressure changes on the retention of removable prostheses and plan treatment accordingly.

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