

## Incidence Of Foreign Bodies In Maxillary Sinus - A Review

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**Abstract:** Foreign bodies in the maxillary sinus being it traumatic cause or iatrogenic injury are usually uncommon. Such Foreign bodies/objects (FB) maybe ingested into the maxillary sinus commonly through oral cavity or nasal cavity and its displacement shows an increasing incidence, especially due to increase in dental procedures such as dental implants, dental restorations etc. These foreign bodies often goes unnoticed and individuals report to clinician only when there is any sinusitis issue or nasal stuffiness or blockage or sometimes in cases with no symptoms, they get accidentally noted during an radiographic assessment for other purposes. This review is to discuss about the anatomy and physiology of maxillary sinus and about the various foreign bodies that can accidentally be ingested in maxillary sinus.

**Keywords:** Foreign bodies, Maxillary sinus, Caldwell-Luc, Sinusitis, Endoscopy

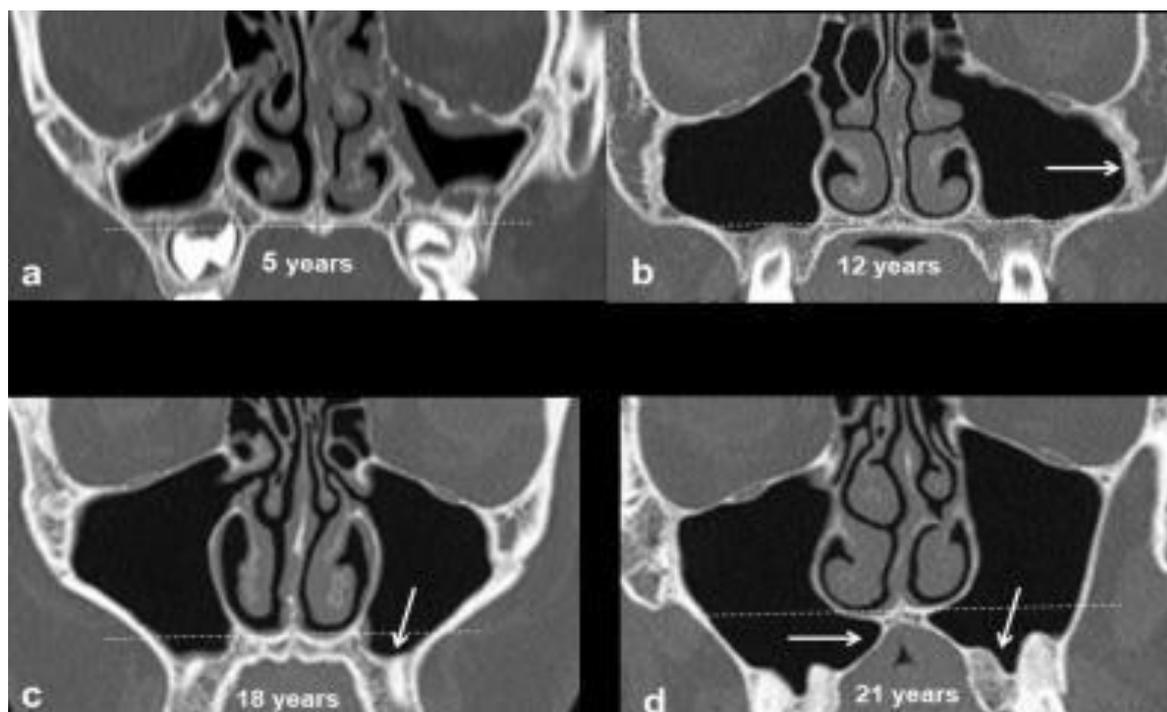
### I. INTRODUCTION

Foreign bodies are objects or pieces of extraneous matter that enter the body accidentally or due to any trauma. Foreign bodies (FB) are occasionally found in paranasal sinus. Paranasal sinus includes four pairs of sinus namely maxillary sinus, ethmoidal sinus, frontal sinus and sphenoidal sinus. These are air-filled spaces within the maxillofacial region that consist of mucosal lining. They communicate with the nasal cavity and forms a unit. Therefore, any object penetrating the sinus can be possibly through means of either oral cavity or nasal cavity and infection in the upper respiratory tract can cause spread of infection to lower respiratory tract also. The possible causes for ingestion of foreign objects in these sinuses include accidental injuries like traffic accidents, explosions, gunshot injuries, metal objects, dental procedures or objects like fractured dental roots, dental implants, dental burs, endodontic materials, impression materials. Foreign bodies can either be superficial or penetrating type. Superficial foreign objects are usually easy to locate and remove it as it would be visible on inspection while objects that have penetrated into the paranasal sinus are more difficult to locate and remove. It is very important to determine if the position of these foreign bodies, whether they are near the vital structure or not. Hence proper investigations such as radiographic assessment need to be done before any surgical procedure followed by surgical retrieval of those objects from the paranasal sinus. Foreign bodies ingestion in dentistry are unusual but are often seen in the maxillary sinus among the various paranasal sinus that are reported. Various studies have reported such incidence leading to failure of the dental treatments. Hence it is important to be aware of risk of such incidents that can occur due to the dental procedures and be cautious. The aim of this review is to understand the anatomy of the maxillary sinus and to discuss about the various causes of foreign bodies reported previously in maxillary sinus and the management.

### 2. MAXILLARY SINUS

#### 2.1 ANATOMY AND PHYSIOLOGY

The maxillary sinus begins to form during the 10th week of intra-uterine life. Ossification of the maxillary sinus starts during the 16th week, from lateral wall of the sinus proceeding towards the anterior wall by 20th week and the posterior wall by 21st week.<sup>1</sup> At birth, the sinus is approximately 10×3×4mm in dimension. In adult after full development the dimensions are reported as 40 × 26 × 28 mm with an average volume of 15 mL . Growth of the maxillary sinus is proportional to the growth of facial bones which occurs in various phases, the first phase at 3 years of life, the second phase taking place at 6-12 years of life and the third phase is the one after pneumatization of the maxillary alveolus, as the permanent molar and premolar teeth erupt displacing the floor of the sinus around 4–5 mm below the floor of the nasal cavity.<sup>2,3</sup> Various studies with the help of 2D and 3D scans state that the size of maxillary sinus development shows gender difference after 8 years of age and it develops till second decade in females and till third decade in males. Also it reported the mean volume of the fully developed maxillary sinus varies according to the ethnicity as reported and is usually larger in males than females.<sup>4</sup> These are paired sinuses, which are pyramidal in shape and are the largest of the paranasal sinus and are filled with air which lie within the maxilla.<sup>5</sup> The anterior wall of the maxillary sinus is formed by the facial surface of the maxilla and it has three landmarks 1) thin canine fossa, 2) infraorbital foramen, 3) infraorbital groove.<sup>6</sup> The posterior wall is covered by infra-temporal surface of the maxilla. The superior wall is covered by orbital floor with the infraorbital groove running through it<sup>6,7,8</sup> and the inferior wall is continuous with the alveolar process. The medial wall forms the lateral wall of nasal cavity and the lateral wall is contiguous inferiorly with the buccal aspect of alveolar ridge.<sup>9</sup>



**Fig 1 : Development of the maxillary sinuses. Up to the age of 12 years, growth of the maxillary sinus is predominantly in a lateral direction (white arrow in b) and after that the sinus expands inferiorly below the level of the nasal floor (white arrows in c, d)Image courtesy : Whyte A, Boeddinghaus R et al: *Dentomaxillofac Radiol*<sup>9</sup>**

The vascular supply of maxillary sinus is primarily derived from the branches of maxillary artery such as posterior superior alveolar artery, infraorbital artery, greater palatine artery and sphenopalatine artery.<sup>6</sup> The maxillary sinus receives general sensation by innervation from the infraorbital and anterior, middle and posterior superior alveolar branches of the maxillary division of trigeminal nerve.<sup>6</sup> Most sensory innervation is provided by the posterior superior alveolar branch, which usually has two to three branches. The lymphatic drainage of maxillary sinus is through the infraorbital foramen or through the ostium and then to the submandibular and deep cervical lymph nodes. The maxillary sinus are lined by bilaminar mucoperiosteal membrane and the membranes has three layers, the periosteum, connective tissue and ciliated pseudo stratified columnar epithelium. The mucosa bound to the underlying periosteum is called as mucoperiosteum and is commonly referred to as the Schneiderian membrane. It also contains cilia and a protective mucous layer secreted by goblet cells in the epithelium and mucous glands in lamina propria which together constitutes the mucociliary apparatus. It acts as a defensive mechanism of respiratory tract to protect inhalation of harmful pollutants, allergens or pathogens by trapping them with the mucus secreted. This mucus is secreted as as two layers, a thin watery layer to allow easy movements of cilia and the other thick sticky layer which helps to trap the airborne particles.<sup>10</sup> The cilia then moves the sticky layer along with the trapped particle to the sinus ostium which moves to the nose and to the nasopharynx.<sup>10</sup> Other uses include humidifying the heat dry air into cold moist air, minimize the bone mass of the skull and improve resonance of voice along with the other sinus.

## 2.2 FOREIGN OBJECTS IN MAXILLARY SINUS

Foreign bodies are seen rarely at times in the paranasal sinuses due to ingestion of various materials that enter the sinus through oral or nasal routes. Among the four pair of paranasal sinus, it is reported that 80% foreign bodies ingestion is in maxillary sinus. The most common causes include the iatrogenic causes, which results due to dental, ophthalmic procedures that constitutes upto 60% of the cases. The other cause is the traumatic incidents, which can be due to external trauma to the sinus region, or indirect trauma to the palate, orbit or nasal injury which accounts upto 25% of the cases.<sup>11</sup> In dentistry, because of antral perforation during the dental procedure involving the apical surgery of maxillary tooth, they often result in a pathway for the entrance of foreign bodies into the maxillary sinus. Various foreign bodies can include dental implants, root apex of the tooth, impression materials, dental burs, broken dental instruments, wooden sticks, toothpicks, needles, pins, glass items, metals, and bullets.

### 2.2.1. Implant Displacement In Maxillary Sinus

Initially in 1981, studies reported that an implant which is longer than the remaining bone could be displaced or ingested into the maxillary sinus.<sup>12</sup> Since then, incidence of implant penetration into the maxillary sinus have been reported regularly which can be proportional to the increase in number of implant placement. Despite its drastic success rate, such incidents happen during the improper surgery, unskilled surgeon, poor implant stability, failure or unsuccessful regeneration of bone following previous surgery in the floor of the sinus as reported.<sup>13</sup> Moreover poor implant stability can cause micro movement of implant and poor implant fixation causes osseointegration, that results in displacement of implants in the later stage.<sup>14</sup> The other possible cause includes incorrect masticatory forces exerting destructive force, an over-sized prosthesis, malocclusion caused by poor retention of prosthesis and more commonly peri-implantitis which destroys the bone, surrounding the implant and thus it results in unsuccessful osseointegration.<sup>15,16</sup> Association between implant displacement and the insufficient height of the maxillary alveolar bone have also been discussed in various studies but it is concluded that the insufficient height can be a risk factor but not a dependent factor for implant displacement.<sup>17</sup> Biglioli and Chiapasco reported that 33% of the 36 implants got displaced into the maxillary sinus due to sinus floor elevation before implantation and Galindo-Moreno reported that 53.3% of implant got displaced similarly.<sup>18</sup> Evidence shows that dental implants in maxillary sinus can result in infection such as sinusitis to serious problems like fungal infection or cancer and hence proper removal of such implants are very important.<sup>19,20</sup>

**2.2.2. Endodontic Materials In Maxillary Sinus**

The close anatomical relationship of the maxillary sinus with the roots of the maxillary molars, premolars and occasionally canines, makes it susceptible to morbid situation resulting from damage due to various dental interventions done. Maxillary sinus involvement may occur during the endodontic treatment due of the extension of endodontic instruments and materials beyond the apices of teeth. On of the study revealed that 14% of the patients (57 cases) showed endodontic materials in sinus out of which 82.5% were root canal filling material (47 cases), impression materials and restorations. The other cases included dental burs, endodontic files, drills bits and other endodontic instruments.<sup>21</sup> One of the case report recorded accidental fracture of gates-gladden drill during the root canal treatment which on radiographic examination was located inside the maxillary sinus.<sup>22</sup>

**2.2.3. Tooth In Maxillary Sinus**

The anatomical relation between the maxillary teeth and maxillary sinus is a complex one, owing to the variable extension of the sinus. Approximately in 50% of the population, the maxillary sinus is in close relation to the roots of the maxillary molar and premolar teeth, particularly deepest point of the maxillary sinus is located close to the first and second permanent molars with the dehiscence rate of 2.2% and 2% respectively. In rare cases the sinus floor can extend as far as the region of the canine root.<sup>23</sup> However due to extensive air spaces, the premolars and the canine teeth may also be exposed into the sinus. Also during extraction, accidental penetration of tooth or broken tooth have also been reported by various studies.

**TABLE I : Accidental causes of foreign bodies in maxillary sinus**

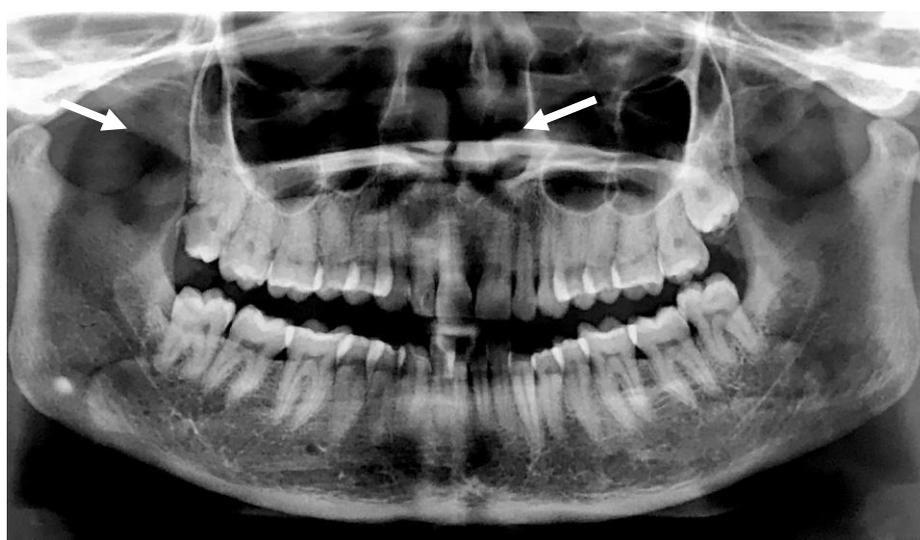
Type of foreign bodies	Site of foreign bodies	Methods of injury	Complication	Management	Reference
Piece of glass	Left maxillary sinus	Road traffic accident	Sinusitis Nasolacrimal duct obstruction	Functional Endo-scopic Sinus Surgery (FESS) and Endoscopic dacryocystostomy	Nataraj et al <sup>24</sup>
Third molar tooth	Right maxillary sinus	Congenital	Sinusitis	Caldwell-Luc	Gurkan et al <sup>25</sup>
Hand sewing needle	Right maxillary sinus	Voluntarily introduced by the patient	Sinusitis	Removed with magnetic iron under local anesthesia	Shao et al <sup>26</sup>
Pressure cooker nozzle	Maxillary sinus	Blast injury	None	Taken out by manipulation with a long- toothed forceps	Agarwal et al <sup>11</sup>
Shell cases	Maxillary sinus	NA	None	Caldwell-Luc	Saeed et al <sup>27</sup>
Wooden toothpick	Left maxillary sinus	Un- known	Unilateral chronic sinusitis	Combined endoscopic and Caldwell-Luc	Sahin et al <sup>28</sup>
Nail	Right maxillary sinus	A piece of metal flew into his right cheek	None	Endoscopy	Pang et al <sup>30</sup>

**Table 2 : Iatrogenic causes of foreign bodies in maxillary sinus**

Type of foreign bodies	Site of foreign bodies	Methods of injury	Complication	Management	Author
Dental implant	Right maxillary sinus	During multiple implantations	Sinusitis	Caldwell-Luc	Mumtaz et al <sup>31</sup>
Gates- Glidden drill	Left maxillary sinus	During endo- dentic treatment	None	Caldwell-Luc	Basturk et al <sup>32</sup>
Root canal filling with extrusion of endodontic obtu- ration material	Right maxillary sinus	During endodontic treatment	None	Open surgical approach	Tanasiewicz M et al <sup>33</sup>
Tooth root	Right maxillary sinus	During extraction	Sinusitis	Middle meatal antrostomy (MMA)	Saruhan N et al <sup>34</sup>
Dental silicone impre- sion material	Left maxillary sinus	NA	Sinusitis	Transnasal endoscopy	Deniz Y et al <sup>35</sup>
Dental implant	Left maxillary sinus	During dental extraction and implantation	None	Middle meatal antrostomy (MMA)	Sireci et al <sup>36</sup>
Surgical bur	Maxillary sinus	During extraction	None	Caldwell-Luc	Smith et al <sup>37</sup>
Zinc oxide cement	Maxillary sinus	NA	None	Caldwell-Luc	Batista et al <sup>29</sup>

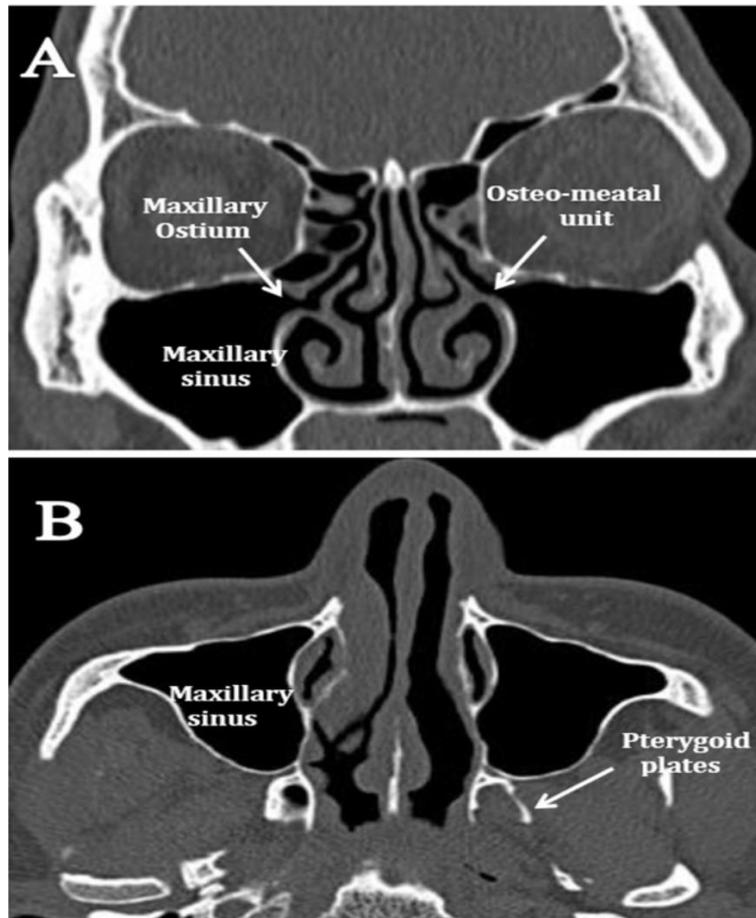
### 2.3 IMAGING TECHNIQUES

Radiographic examination of the maxillary sinus may be carried out by a wide variety of options like periapical radiographs, occlusal radiographs, panoramic radiographs, paranasal sinus views and other facial views to confirm or rule out any pathology of the maxillary sinus. On periapical radiographs, the maxillary sinus border appears as a thin, delicate radio-opaque line and is seen as a fusion of lamina dura and floor of sinus. The disruption of the continuity of the lamina dura in the periapical area is the first sign of periapical pathology. The technique of 2-dimensional panoramic imaging was introduced in the first half of the 20th century. It is especially used in the initial diagnostic phase of the maxillary sinus to its pathological conditions. In panoramic radiography, the central radius goes almost straight toward the longitudinal axis of the molars resulting in minimal projection error. Furthermore, local swelling of the sinus membrane and opacities can be diagnosed.<sup>38</sup>



**Fig 2: Panoramic radiograph, White arrows showing maxillary sinuses**

Computerized tomography (CT) and magnetic resonance imaging (MRI) have become increasingly important for evaluation of sinus pathologies. They provide multiple sections through the sinus at different planes and thus contribute to final diagnosis and determine the extent of the disease.<sup>39</sup> These 3-dimensional imaging techniques take coronal and axial sections, since coronal sections through dental fillings, crowns and metallic restorations can result in artifacts, axial sectioning is also carried out. Another imaging technique included Cone beam computerized tomography (CBCT). In one of the studies involving CBCT and panoramic radiography, it was reported that there is a moderate risk for misdiagnosis of the maxillary sinus, if panoramic radiography is used alone rather than CBCT is used and also panoramic radiography led to false-negative and false-positive findings



**Fig 3: Computerised tomography, (A) Coronal CT image of normal maxillary sinus and ostium (B) Axial CT image of normal maxillary sinus Image courtesy : Abhay G. Kakade ; MVP Journal of Medical Sciences <sup>43</sup>**

Additional information can be obtained with the help of specialised skull views.<sup>40</sup> The occipito-mental or Water's projection is optimal for the visualisation of the paranasal sinuses, including the maxillary sinuses. Other than that submentovertex, postero-anterior and lateral skull views can also show the maxillary sinus towards some extent. But unfortunately, these specialised skull views have low rates of sensitivity and hence are replaced by computerised tomography (CT). Ultrasound is another safe, non-invasive technique that has been reported to diagnose the sinus pathologies and shows that in adults, ultrasound was 90% and radiography was 82% accurate in detecting fluid in maxillary sinus. Various authors have concluded that ultrasound also provides an excellent method of screening the sinus pathologies at comparatively low cost than that of other imaging techniques.

### 3. MANAGEMENT

#### 3.1 Caldwell - Luc Technique

The Caldwell-Luc operation is a well-established procedure for removal of foreign bodies from sinus and other sinus pathologies. This operation was considered as a prime surgical management before the development of the antibiotics and endodontic surgery. The Caldwell-Luc approach opens the canine fossa and allows access to the foreign body inside the maxillary sinus. Recently Endoscopic sinus surgery is an arising choice of treatment now-a-days rather than the Caldwell-Luc procedure. Despite the success of endoscopic surgery, various evidence indicate use of Caldwell-Luc operation as it provides good access to the sinus, peri-sinus, and pterygo-maxillary fossa and also it can provide a wide access to foreign bodies that cannot be removed endoscopically because of the size of the object and displacement. If implant displacement has

caused an oro-antral fistula, then an intraoral approach, such as the Caldwell-Luc approach, is essential to close the oro-antral fistula.<sup>41</sup>

### 3.2 Endoscopic Surgery

Endoscopic sinus surgery has currently been replacing Caldwell-Luc procedure because excessive tears of the maxillary sinus mucosa are less likely in this method and it is less invasive than the Caldwell-Luc approach, reducing injuries or bleeding in the mucosa.<sup>42</sup> Removal of the foreign bodies using endoscopy is classified into two categories which can be an approach from the nasal cavity or an approach from the oral cavity. Nasal approach is done via natural ostium and it is minimally invasive. Yet the limitation of this approach include size of the foreign bodies.<sup>42</sup> In oral approach, a small incision is made in the canine fossa, following which an endoscope is used. This is also referred to as functional endoscopic sinus surgery.<sup>42</sup> It is comparatively better than nasal approach and is minimally invasive with low incidence of complications.

### 3.3 Lateral Window Technique

In this technique a full thickness flap is elevated to reveal the lateral sinus wall of maxilla, the sinus membrane is elevated, then on the lateral wall of the sinus, a window is created. It then allows the insertion of graft material to be placed or sometimes used to extract the foreign bodies. This is usually used in sinus augmentation or implant placement procedures. But it is also reported to be used for foreign bodies removal from maxillary sinus.

### 3.4 Middle Meatal Antrostomy

MMA is a surgical procedure which is done by enlarging the opening (ostium) of the maxillary sinus followed by surgical intervention. The three main goals to accomplish during this technique is to remove the uncinate process, find natural opening into the maxillary sinus, enlarge the opening followed by extraction of the foreign bodies. Though this method is used in some patients, it is not the best due to a high failure rate without guarantee of better surgical outcomes.

## 4. CONCLUSION

The displacement of foreign bodies into the maxillary sinus occurs unexpectedly and its is also difficult to manage. In most of the patients these foreign bodies in sinus goes un-noticed and are usually detected when the patients comes with unexplained complain of rhino-sinusitis, or as an accidental finding during radiological examination. And when it is detected, it is very important to remove the object or it can lead to various complications like chronic sinusitis, fungal infections or inflammatory reactions. Various methods are available to extract the foreign body from sinus based of the size, shape and location of the objects. Thus is it important to be aware of such incidents in general or private practise for early diagnosis and management.

## 5. CONFLICT OF INTEREST

Conflict of interest declared none.

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