Unexpected metallic foreign bodies on panoramic scans – a narrative review

Unerwartete metallene Fremdkörper auf Panoramaschichtaufnahmen – eine Übersicht

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ABSTRACT

Background The digital panoramic radiograph (orthopantomogram, OPG) is the standard radiographic technique for basic diagnostics in dental practice. A correctly taken image provides a good overview of teeth and jaw, whereas radiopaque foreign materials, e. g. metal, can obscure relevant findings.

Methods A literature review on unexpected metallic foreign bodies in OPG was performed to determine the spectrum of metallic foreign bodies that may cause radiopaque areas on panoramic radiographs in routine clinical use.

Results and Conclusion A total of 37 different unexpected metallic foreign bodies were found. They can be categorized as jewelry, clothing, personal protective equipment, medical devices, iatrogenic foreign bodies, and rare incidental findings. Radiopaque foreign materials in the OPG are often relatively easy to recognize as artifacts because of their location, and they are avoidable in most cases. If unclear, a three-dimensional radiograph was helpful for determining the location. Radiopaque areas caused by foreign bodies can lead to misinterpretation or partial or complete non-evaluability and should therefore be avoided.

Key Points:

- The OPG is the standard radiograph for dentists, oral surgeons, and oral and maxillofacial surgeons.
- Foreign bodies made of metal can lead to non-evaluability of panoramic radiographs. Based on a review of the literature and exemplary radiographs, this article provides an overview of rare but typical metallic foreign bodies in OPG, thus addressing the problem of the subfield of radiography by making radiologists more familiar with these images.
- The spectrum of unexpected metallic foreign bodies includes unremoved earrings with the typical ghost images on the contralateral side, piercings, hearing aids, acupuncture needles, rare iatrogenic foreign bodies, incidental findings in infants in the nose and external auditory canal, vascular clips after surgical interventions, and ritual subcutaneous foreign materials.

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ZUSAMMENFASSUNG

Hintergrund In der zahnärztlichen Praxis stellt die digitale Panoramaschichtaufnahme (Orthopantomogramm, OPG) als konventionelle Röntgenaufnahme die Standardröntgentechnik zur Basisdiagnostik dar. Eine korrekt angefertigte Aufnahme bietet eine gute Übersicht über Zähne und Kiefer, während röntgendichte Fremdmaterialien z. B. aus Metall relevante Befunde verschleiern können.

Methode Es wurde eine Literaturrecherche zu unerwarteten, metallenen Fremdkörpern im OPG durchgeführt, um das Spektrum an Metallfremdkörpern zu ermitteln, die in der routinemäßigen klinischen Anwendung röntgendichte Areale auf Panoramaschichtaufnahmen verursachen können.

Ergebnisse und Schlussfolgerung Insgesamt 37 unterschiedliche unerwartete, metallene Fremdkörper wurden gefunden. Sie lassen sich den Kategorien Schmuck, Kleidung, persönliche Schutzausrichtung, medizinisch-technische Hilfsmittel, iatrogene Fremdkörper und seltene Zufallsbefunde zuordnen. Radioopake Fremdmaterialien im OPG sind aufgrund ihrer Lokalisation häufig relativ leicht als Artefakt zu erkennen und sie sind in den meisten Fällen vermeidbar. Bei Unklarheiten kann eine dreidimensionale Röntgenaufnahme zur Lokalisation hilfreich sein. Durch Fremdkörper hervorgerufene röntgenopake Bereiche können zu Fehlinterpretationen bzw. zur teilweisen oder vollständigen Nichtauswertbarkeit führen und sollten daher vermieden werden.

Kernaussagen:

- Das OPG ist bei Zahnärzten, Fachzahnärzten für Oralchirurgie sowie Fachärzten für Mund-, Kiefer- und Gesichtschirurgie die Standardröntgenaufnahme.
- Fremdkörper aus Metall können zur Nichtauswertbarkeit der Panoramaschichtaufnahme führen. Der Beitrag bietet anhand einer Literaturübersicht und exemplarischer Röntgenaufnahmen eine Übersicht zu seltenen, aber typischen metallenen Fremdkörpern im OPG und trägt damit der Problematik des Teilgebietsröntgen Rechnung, indem sie den Radiologen mit diesen Aufnahmen vertrauter macht.
- Das Spektrum unerwarteter, metallener Fremdmaterialien reicht von nicht abgenommenen Ohrringen mit den typischen Geisterbildern auf der kontralateralen Seite über Piercings, Hörhilfen und Akupunkturnadeln sowie seltenen iatrogenen Fremdkörpern und Zufallsbefunden bei Kleinkindern in Nase und äußerem Gehörgang bis hin zu Gefäßclips nach chirurgischen Eingriffen und rituellen Fremdmaterialien in der Haut.

Introduction

The imaging techniques used in dentistry include digital panoramic radiography (orthopantomography), single-tooth radiography, bitewing X-ray, digital volume tomography (DVT), as well as computed tomography (CT) of the head, magnetic resonance imaging of the temporomandibular joints, and recently magnetic resonance imaging (dental MRI) [1–3]. Dental imaging comprises approximately 40 % of radiography examinations performed in Germany. For this reason, profound of dental imaging is essential for clinical radiologists [3]. Panoramic radiography is considered the standard imaging technique among dentists, oral surgeons, orthodontists, and oral and maxillofacial surgeons [4].

Orthopantomography is a projection radiography method and is based on conventional X-ray tomography. Refer to the corresponding literature for information regarding the complex techniques of the panoramic radiography method [3, 5, 6]. The orthopantomogram (OPG) includes the teeth of the upper and lower jaws, the temporomandibular joints, and parts of the maxillary sinus [3]. The OPG thus provides an overview of all teeth and the jaws and information about neighboring regions. The following three radiological quality features are defined for panoramic radiographs [3]:

1. Free symmetrical projection of the mandibular ramus including the condylar process,
2. Grayscale differentiation, and
3. A “real” dimensionally accurate representation of the dental crowns of the maxillary anterior teeth.

Typical disadvantages and artifacts of the imaging technique, e. g., fuzzy projection of radiopaque foreign bodies on the opposite side, are known [3]. Further issues are a certain unsharpness of the image, summation effects, enlargement and distortion of individual regions due to the cross-sectional imaging method [7]. Therefore, it is even more important to avoid factors that reduce image quality [7]. In addition to this special imaging feature and patient positioning mistakes, distinctive anatomical features can result in diagnostic difficulties requiring consultation with a radiologist as a medical imaging expert. Metallic objects in the orofacial region can result in artifacts and ghost images on the OPG. Therefore, this article is focused on metallic foreign objects in panoramic radiography in order to familiarize radiologists with these rare but ultimately typical incidental findings. Since radiologists are not routinely involved in the evaluation of dental images as a subfield of radiography but can be consulted in the case of diagnostic difficulties, we humbly offer an overview of metallic artifacts in panoramic radiography.

Method

The PubMed, Cochrane Library, and Google Scholar databases were searched for unexpected metallic foreign bodies in panoramic radiography. The search terms included “panoramic radiograph”, “orthopantomogram”, “dental radiography”, “incidental finding”, “metal” and “foreign body”. Studies published between 1990 and 2022 in German or English were included.

Metallic foreign bodies regularly seen in dentistry, oral surgery, and oral and maxillofacial surgery at a specific location in the clinical routine were excluded. These include amalgam fillings, gold inlays, partial crowns, crowns, bridges, endodontic posts, enossal implants, and osteosynthesis material. Panoramic radiographs collected by the authors in the clinical routine at various centers over many years for training purposes were used for result presentation.

▶ **Table 1** Categorization of found metallic foreign bodies.

Category	Examples
I. Jewelry	▪ Earrings in various shapes and sizes ▪ Extraoral and intraoral piercings ▪ Necklaces ▪ Barrettes and hairpins ▪ Susuks and charm needles
II. Clothing	▪ Zippers ▪ Buttons
III. Personal protective equipment	▪ Face mask
IV. Medical devices	▪ Lead apron ▪ Glasses ▪ Hearing aids/cochlear implants ▪ Acupuncture needles
V. Iatrogenic foreign bodies	▪ Surgical needles ▪ Broken instruments, e. g. diamond burs and Lindemann burs, elevator blades, injection needles, etc. ▪ Metallic vascular clips for stopping blood flow during surgical interventions ▪ Temporary prostheses ▪ Permanent dental prostheses ▪ Epitheses ▪ Stents ▪ Wire ligatures for fixation of a drainage tube ▪ Plates and screws in cervical spine spondylodesis
VI. Other rare incidental findings	▪ Shrapnel, pellets, shell splinters ▪ Earrings impacted in the earlobes ▪ Foreign bodies in the outer ear canal in children, e. g., jewelry, small batteries, buttons, etc. ▪ Foreign bodies in the nose, primarily in children, e. g., beads, staples, etc. ▪ "Missing" orthodontic fastening elements ▪ Thin gold threads for face lift

Results

The literature includes numerous case reports, case series, and pictorial essays. Also, some general information and radiographs can be found in dental radiology textbooks, for example, the textbook by Andreas Fuhrmann (2013), which includes a section in the chapter on panoramic radiographs that discusses the problem of radiopaque metallic structures in the beam path and contains a collection of cases [5]. The textbook on panoramic radiographs by Jürgen Düker (2000) also contains some corresponding images [6]. However, only two articles report unexpected radiopacity of foreign bodies in dentistry. The study by Omezli et al. (2015) is a retrospective evaluation of 11 887 panoramic radiographs including 62 images (0.6 %) with foreign bodies in the jaw. In this study, the foreign bodies included only filling materials (amalgam, root canal material), a staple, and shrapnel [8]. The study by Hwang et al. (2019) included panoramic radiographs as well as CT scans and DVT scans and the foreign bodies were not limited to metal objects. The authors of this study investigated 508 images with foreign bodies. 19 different types of foreign bodies were found. The examiners divided the radiopaque materials into two categories: intentional and unintentional insertion [9].

A clear-cut categorization as intentional/unintentional is not always possible. In this respect, after review and evaluation of the literature and comparison with our own cases involving metallic foreign bodies on OPG, the foreign bodies were able to be divided into six categories: jewelry, clothing, personal protective equipment, medical devices, iatrogenic foreign bodies, and rare incidental findings (▶ **Table 1**).

I. Jewelry

Earrings

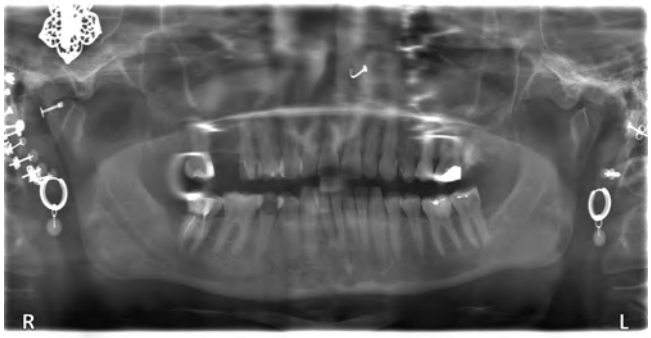
Earrings are seen on panoramic radiography in various numbers, sizes, and shapes (▶ **Fig. 1, 2**). Earrings not removed for the scan can potentially result in projection-dependent artifacts (ghost images) on the contralateral half of the face (▶ **Fig. 3**). The literature includes publications that provide a detailed technical description of the ghost image phenomenon [10, 11]. Ghost images can obscure or completely mask relevant findings. In a case report of a 30-year-old patient who said she could not easily remove her earrings for the radiography examination, the earrings were projected onto an ectopic wisdom tooth high in the maxillary sinus on the lower edge of the eye socket so that it was completely masked by the artifact on the OPG and could only be detected on a new radiograph without her earrings [11].

Extraoral and intraoral piercings

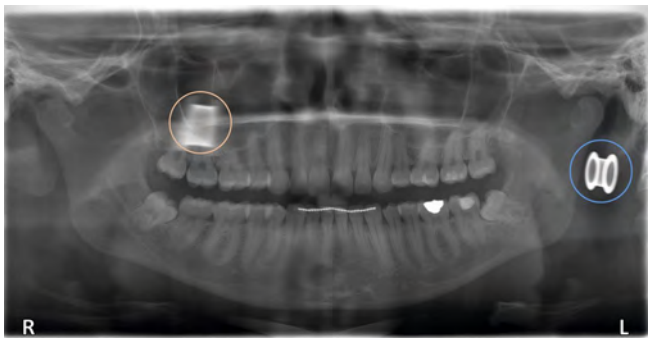
Piercings not removed from the nose, upper lip, lower lip (▶ **Fig. 4**) or other external skin areas in the region of the head and neck are rare but ultimately typical foreign bodies on panoramic radiographs. Intraoral piercings of the tongue, frenulum, and the uvula can also mask findings on radiographs.

Necklaces, barrettes, and hairpins

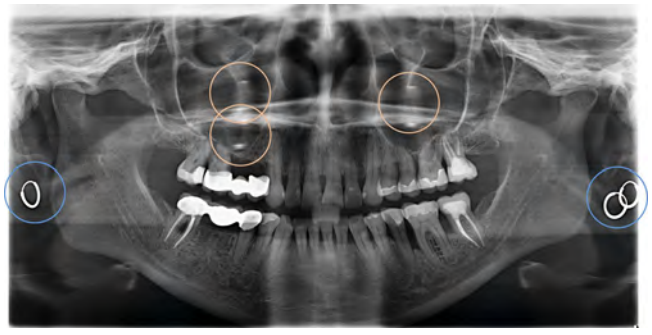
Necklaces not removed prior to imaging can be clearly seen on radiographs. Metallic barrettes and hairpins (▶ **Fig. 5**) result in



▶ **Fig. 1** Multiple earrings in various shapes and sizes and other external face jewelry result in multiple artifacts on a radiograph during an initial dental workup. For example, the apical regions of teeth 17 and 24–26 cannot be evaluated on this image.



▶ **Fig. 2** This radiograph acquired during the initial dental workup shows a missing premolar with space closure on both the right and left side of the upper jaw. Wisdom teeth 18, 28, 38, and 48 are present. Lower wisdom teeth 38 and 48 are partially impacted. A retainer is attached to teeth 33–43 at the front of the lower jaw. As a secondary finding, a "tunnel" (blue circle) in the left earlobe and a corresponding ghost structure (pink circle) can be seen. These make it impossible to evaluate the roots of teeth 18 and 17.

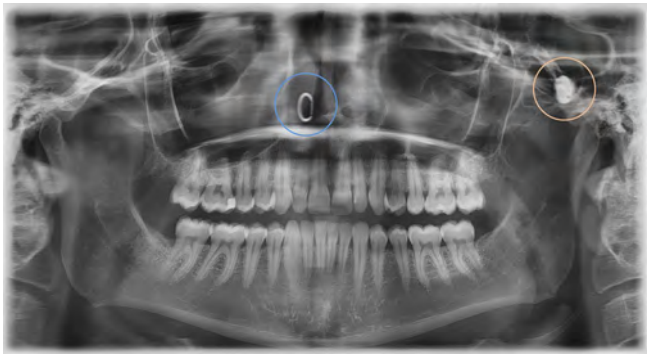


▶ **Fig. 3** The OPG was acquired upon initial presentation of a new patient. Bone loss in the upper and lower jaws and three molars (27, 37, and 47) with root canal filling can be seen. As a secondary finding, three earrings (blue circles) with corresponding ghost images (pink circles) can be seen on the contralateral side in the region of the maxillary sinus.

▶ **Fig. 4** This OPG acquired upon initial presentation of the patient shows elongated wisdom tooth 28 with extensive caries, persistent baby teeth 75 and 85, and a hyperdense structure at the distal root tip of tooth 37. The patient's piercing (blue circle) in the center of her lower lip is projected onto the crown of the lower left canine.

localized artifacts on the upper edge of the image. The metal core of hair ties can cause shadows (▶ **Fig. 6**). Certain synthetic hair ex-

▶ **Fig. 5** The OPG acquired as part of a routine dental examination shows multiple radiopaque fillings, teeth 24 and 37 with root canal fillings, and tartar on the distal surface of elongated wisdom tooth 18. The patient is wearing barrettes (blue circles) on both sides of her head.



▶ **Fig. 6** This routine image of a 31-year-old patient shows a piercing in the right nostril (blue circle) and a hair band with a small metal logo (pink circle) that projects cranial to the left condyle. The teeth and jaw sections with teeth are unremarkable.

tensions can also result in diagnostic difficulties [12]. These can be seen on panoramic radiographs as linear or curvilinear opacities with diffuse edges that stretch vertically over the entire image [13].

Susuks

Susuks or charm needles are a special type of cultural practice in Southeast Asia, primarily in Malaysia, Thailand, Singapore, Indonesia, and Brunei [14–16]. Susuks are thin metal pins made of silver, gold, or alloys thereof that are between 5 and 10 mm long and have a diameter of approximately 0.5 mm. Susuks are supposed to make the wearer more attractive, maintain youth, promote health, reduce pain, and bring success in business or career [15, 17]. These objects are implanted under the skin primarily in the orofacial region, especially the chin. On panoramic radiography, they appear as radiopaque needle-like objects [17]. Some case reports include panoramic radiographs with one or more susuks and charm needles [15–17]. The authors agree that susuks can be confusing since they are not overtly visible and palpable [14–17].

▶ **Fig. 7** OPG to search for potential source of infection and evaluate the remaining teeth to determine a treatment plan performed in accordance with pandemic protective measures. The patient's face mask appears as three parallel lines in the upper region of the image (blue arrow). Abutment tooth 35 for the bridge in the left lower jaw is broken.

II. Clothing

Buttons or zippers made of metal on the front or back of a patient's clothing are usually easy to identify on radiographs due to location and texture.

III. Personal protective equipment

As a result of COVID-19 protective measures, radiological examinations were often performed with patients still wearing a face mask. The metal nose clips incorporated in masks to ensure a better fit to the contours of the face are seen as a curvilinear opacity with one, two, or even three rows, depending on the design. These lines are typically located median to the upper edge of the image or are superimposed on the nasal conchae (▶ **Fig. 7**). The course depends on the projection but asymmetrical placement of the mask also affects the course of the artifact.

IV. Medical devices

Medical devices include lead aprons, glasses, hearing aids, and acupuncture needles. A lead apron that is positioned too high results in artifacts in the lower jaw-anterior tooth region (▶ **Fig. 8**). Glasses have a strange appearance on radiographs (▶ **Fig. 9**) but can be readily identified as such and these artifacts are certainly easily avoidable [6]. External hearing aids and cochlear implants can also be easily identified on panoramic radiographs because of their typical location (▶ **Fig. 10**). Acupuncture needles can also appear on radiographs as incidental findings.

V. Iatrogenic foreign objects

Rotating instruments

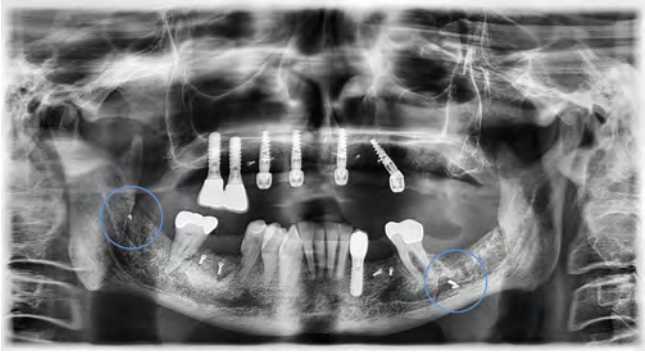
Broken dental and Lindemann burs are relatively common findings in panoramic radiography [18]. Lindemann burs are used for the surgical extraction of wisdom teeth or for the formation of

▶ **Fig. 8** The OPG acquired upon initial presentation of the patient shows advanced bone loss in the upper jaw as a relevant primary finding. Teeth 24 and 36 have caries in the distocervical region. Artifacts (blue arrows) caused by the lead apron being positioned too high can be seen in the center of the lower jaw.

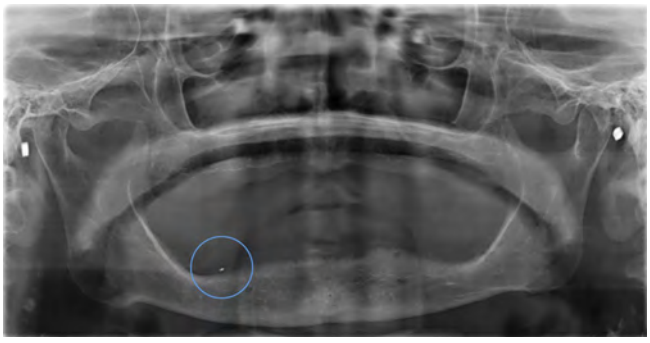
▶ **Fig. 9** Radiograph for dental prosthesis planning performed with the patient still wearing glasses. An earring (blue circle) in the left earlobe and its corresponding ghost structure on the contralateral side (pink circle) and the lead apron (blue arrow) in the chin region can also be seen.

▶ **Fig. 10** 4 osseointegrated implants in the upper jaw can be seen on this control radiograph of a patient with all-on-4 implants. 2 teeth with root canal fillings and a fractured retained root in region 44 can be seen in the lower jaw. The patient's hearing aids (blue circles) can also be seen on both sides.

bone blocks for bone augmentation. They can usually be easily identified based on their location and shape (▶ **Fig. 11**). However, the exact position cannot be determined with a two-dimensional scan. In their case report, Chen et al. (2020) describe the recovery of a fissure bur the broke during extraction of the left mandibular



▶ **Fig. 11** The control radiograph acquired after the implantation of implants in upper jaw regions 14, 12, 21, and 24 shows two broken Lindemann burs (blue circles) in regions 37 and 48 of the lower jaw that were used for the removal of bone block. In addition to the 7 enossal implants, multiple mini-screws for the fixation of bone blocks can be seen.



▶ **Fig. 12** The OPG acquired to evaluate the bone for supporting a dental prosthesis shows a highly atrophied alveolar ridge in the upper and lower jaws. Residual amalgam particles (blue circle) in the jaw and in the mucous membrane covering the alveolar ridge can be seen. Two opacities caused by earrings can be seen on the lateral edge of the image and there are corresponding ghost structures in the region of the eye socket.

third molar. The authors used a reference frame to remove the fragment in a targeted manner [19]. Broken twist drills in dental implantation have also been reported [20].

Surgical instruments

Other iatrogenic metallic foreign bodies can certainly cause diagnostic difficulties. For example, Demirkol (2015) reported an object with pronounced radiodensity on OPG in the region of the extraction wound of tooth 16 in a 45-year-old patient. This foreign body imitated a dental implant with respect to its location, axial alignment, and size. The patient reported a traumatic tooth extraction but no dental implant. The location of the radiopaque foreign body was determined with a DVT scan. The foreign body was located in region 16 within the maxillary palatal mucosa. Under local anesthesia a broken elevator blade was able to be removed [21].

The literature also includes several case reports on surgical needles left in the surgical field. One report describes a case involving a 23-year-old patient who underwent panoramic radiography due to tooth pain. A needle was visible in the angle of the jaw on the right side beneath the mandibular canal. According to the patient's medical history, she had undergone a tonsillectomy when she was 4 years old [22]. However, retained suture needles are more commonly the result of oral surgery as described by Sencimen et al. (2010). In this study, a needle accidentally left in the pterygomandibular space during extraction of the upper third molar was removed intraorally using C-arm fluoroscopy [23].

Injection needles

Broken injection needles used for local anesthesia are a rarity today due, among other things, to the introduction of disposable injection needles [24–28]. Nonetheless, there are occasionally reports of this rare event and the removal of needles broken during the administration of nerve block. For example, an 18-year-old patient underwent extraction of four wisdom teeth one year prior by her dentist. The injection needle used to anesthetize the right mandibular nerve broke and was left in place because recovery of the fragment deemed possible [27]. The patient was referred to an oral and maxillofacial surgery clinic one year later due to pain. The acquired OPG showed the needle in the right pterygomandibular space. Removal was performed after a CT scan with the support of a surgical navigation system [27]. In a similar case in which removal was performed without the use of three-dimensional radiography, the authors specified incorrect administration of the local anesthesia, movement of the patient during injection, and manufacturing defects as the reasons for the fracture of the 35-mm needle used to administer the nerve block [25].

Amalgam

Further metallic foreign bodies typically seen in the oral cavity include small pieces of amalgam dispersed into the jaw bone or tissue during tooth extraction (▶ **Fig. 12**) and implants that migrated into the maxillary sinus or the paranasal sinuses [29, 30]. These cases are often implants that were implanted in bone with a low residual bone height in the upper jaw posterior region and there was a subsequent lack of osseointegration or implants that were driven into the maxillary sinus by mechanical trauma. Due to the location in the paranasal sinuses, these foreign bodies are considered unexpected.

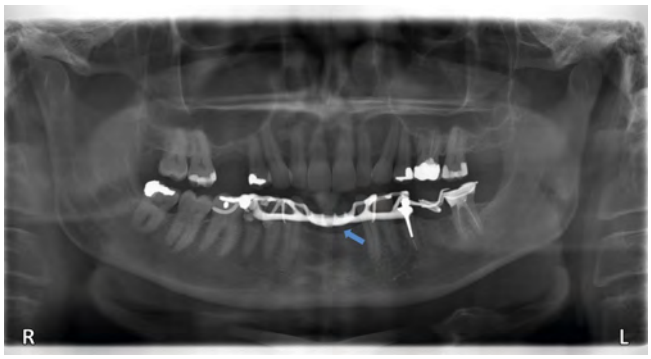
Vascular clips for stopping blood flow

Further iatrogenic foreign bodies include vascular clips used in the head and neck region, e. g. to stop blood flow during neck dissection (▶ **Fig. 13**). These non-ferromagnetic clips are often made of titanium or titanium alloys or can be made of absorbable plastic. Vascular clips are intentionally left in place and are not foreign bodies requiring removal.

Removable dental prostheses and epitheses

If the patient was not asked to remove a removable dental prosthesis prior to radiography, the resulting images may not be diagnostic [7]. In addition to permanent removable dental prostheses (total prostheses with metal frame, partial dentures, and telescopic prostheses) (▶ **Fig. 14**), removable prostheses can also be

▶ **Fig. 13** 6 implants and 3 teeth with root canal fillings can be seen on the OPG acquired for routine dental control. A provisional restoration is located in region 24. Titanium vascular clips (blue circle) can be seen in the left angle of the jaw as a secondary finding. The patient history included tongue cancer (left) with neck dissection. The vascular clips were used to stop blood flow during lymphadenectomy.

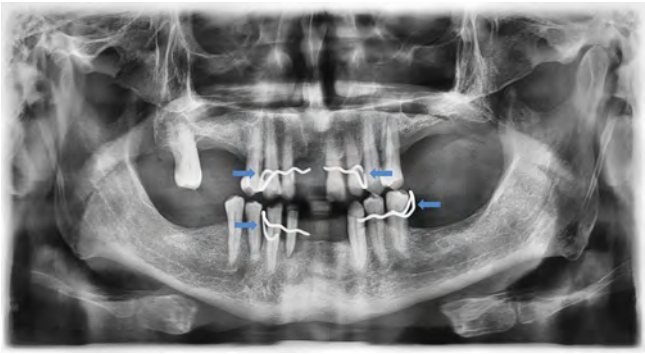


▶ **Fig. 14** The routine radiograph shows a metal post in the region of the root of tooth 35 and amalgam fillings in teeth 14, 25, 46, and 48. The partial denture (blue arrow) replacing missing teeth of the lower jaw (36, 32–42) makes it difficult to perform a further diagnostic workup of the clinical crowns of the lower jaw.

temporary, e. g., a temporary prosthesis with hand-bent wires (▶ **Fig. 15**).

Moreover, epitheses can have metal parts, e. g., the anchoring elements. Therefore, if they are not removed during imaging and are located in the beam path, they can result in avoidable foreign bodies on the OPG.

As a further type of iatrogenic foreign body, stents used for keeping vessels open can be visualized as tube-shaped spiral wire prostheses on panoramic radiographs (▶ **Fig. 16**). Wire ligatures for securing drainage tubes can also be unintentionally visualized (▶ **Fig. 17**). Stabilizing interventions involving the cervical spine, such as plates and screws used in cervical spine spondylodesis, can also be visualized on panoramic radiographs (▶ **Fig. 18**).



▶ **Fig. 15** After paradontitis treatment, this OPG was acquired in a 76-year-old patient for permanent dental prosthesis planning. The temporary dental prosthesis was not removed for the radiograph. The patient is wearing a temporary prosthesis on the upper and lower jaws with hand-bent wires (blue arrows) as retaining elements.

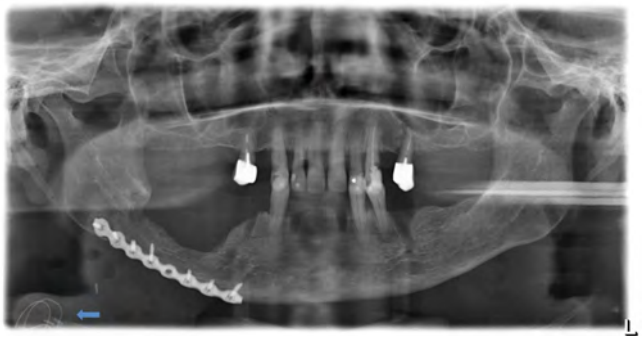
VI. Other rare incidental findings

There are other foreign bodies that cannot be assigned to the aforementioned categories and cause very rare incidental radiological findings. This includes shrapnel, pellets, and shell splinters [8, 31–33] as well as accidental insertion of foreign bodies into the earlobes, the outer ear canal, and the nose [34]. The literature includes a case report of a 16-year-old patient referred to an orthodontic clinic by her treating orthodontist for extraction of her wisdom teeth. A foreign body was seen on the preoperative OPG in the region of the right earlobe. According to her parents, an earring had disappeared 12 years earlier. Surgical incision revealed an impacted earring. In summary, the patient history was decisive for diagnosing the problem [35]. Foreign bodies made of metal can also be seen in the outer ear canal – in addition to the already mentioned hearing aid [36, 37].

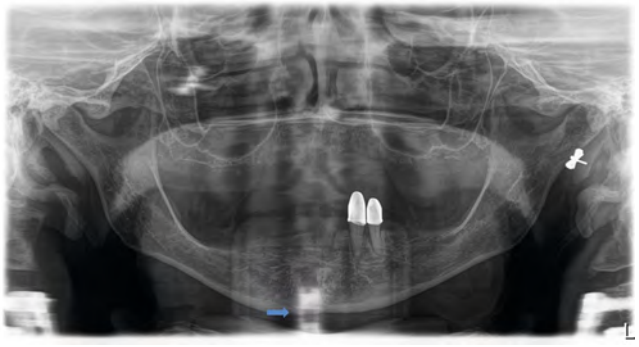
Some case reports discuss foreign bodies commonly seen in the noses of children. The spectrum of objects ranges from jewelry to small batteries, buttons, and toys [34, 38]. For example, Habibullah et al. (2010) report on an unusual OPG of an 8-year-old boy with hyperactivity. Surgery was planned for this patient due to a two-week history of swelling and multiple broken teeth. Preoperative radiography showed an intranasal foreign body. Two beads, one staple, and a piece of an eraser were discovered. Inspection of the ear canals was unremarkable. 3D imaging was not necessary [39]. Of course, such foreign bodies can go undetected for years as described by Tay et al. (2000) in a case report [40].

▶ **Fig. 16** Routine imaging in an 82-year-old patient shows significant crown and bridge restorations in the upper and lower jaws. 3 enossal implants can be seen in the lower jaw. A stent in the left carotid artery (blue arrow) can be seen as a secondary finding.

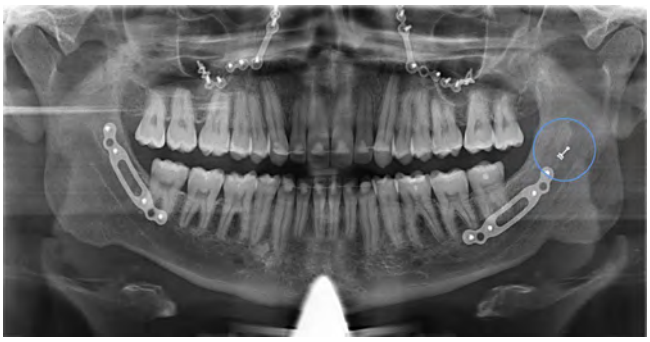
Another rarity is an orthodontic fastening element lost during orthognathic surgery, which was an incidental finding on a control



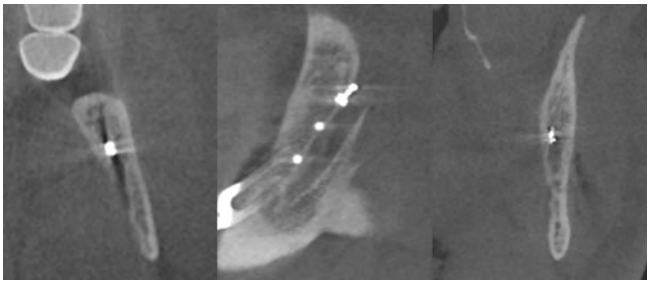
▶ **Fig. 17** Postoperative OPG after tumor resection and prophylactic stabilization of the ramus with a fracture plate: a wire ligature (blue arrow) for a drainage tube can be seen as an artifact right lateral on the lower edge of the image. In addition, a titanium perforated plate can be seen in the mandible on the right, which includes a blurring structure on the contralateral side.



▶ **Fig. 18** An anterior plate for cervical spine spondylodesis (blue arrow) is partially visualized on the radiograph of a severely compromised dentition acquired for the purpose of dental prosthesis planning. Corresponding ghost structures can be seen on the right and left edges of the image. An earring in the left earlobe with corresponding ghost structure on the lower edge of the right eye socket can also be seen.



▶ **Fig. 19** Osteosynthesis plates on the mandibular rami and the maxilla can be seen on this routine image acquired after an adjustment osteotomy. An artifact caused by a lead apron can be seen on the lower edge of the image. An orthodontic fastening element (blue circle) that was used for the fixation of splints during adjustment osteotomy became detached intraoperatively and migrated into the medullary cavity of the left ascending mandibular ramus is seen as an incidental finding. It was initially assumed that this fastening element had migrated to the masseter muscle. It was unanimously decided to adopt a watch and wait approach. A DVT scan was acquired two years later to check the consolidation progress. The image showed that the sagittal mandibular osteotomy was the point of entry through which the element migrated between the laminae. Based on this, treatment was still not considered necessary. On the image the "bracket" differs from what was initially assumed to be a piercing based on the significantly higher contrast. Due to the distance from the focal plane, the margin of piercings typically appears less sharp.



▶ **Fig. 20** Cross section of the foreign body from Fig. 19 on three planes at the points with the greatest size. Two years postoperative bone has grown around the foreign body in the region of the sagittal osteotomy and in close proximity to the mandibular canal.

radiograph (▶ **Fig. 19**) and was then located with a DVT scan (▶ **Fig. 20**). Finally an interesting rare incidental finding is the gold thread lift surgical technique in which 0.1-mm gold threads are used to lift the face. These gold threads appear on radiographs as irregular radiopaque, thread-shaped artifacts that make interpretation of an orthopantomogram difficult and can result in mistakes during three-dimensional implant planning [41, 42].

Discussion

Various metallic foreign bodies can cause artifacts on panoramic radiographs. These image artifacts are largely preventable since the presence of metallic foreign bodies is usually known in advance and they can be removed, but sometimes they can be unexpected. Metallic foreign bodies can be divided into avoidable and unavoidable. Such a categorization would certainly be suitable for most foreign bodies. However, it is unclear whether the "migrated" fastening element from ▶ **Fig. 19** would not have been avoidable based on this argument if the treating physician had not lost it intraoperatively. In some cases, the patient's medical history was helpful for clarifying the cause of the problem, while in other cases additional three-dimensional imaging was needed for identification or removal of the foreign body. Clear identification and allocation of foreign bodies and careful practices on the part of medical personnel continue to be more important than a formal classification. All jewelry should be removed from the head and neck region prior to acquisition of radiographs [11]. Arguments against removal on the part of the patient, e. g., tongue piercings are difficult to remove, should not be an obstacle to removal. If possible, medical devices should also be removed since they can hide or obscure potentially important findings. When using a lead apron, it must be positioned and placed

correctly. Folds in the apron must be avoided. Iatrogenic foreign bodies in the region of jaw segments with teeth are comparatively less problematic for dentists. In addition to the foreign bodies made of titanium, lead, gold, silver, or the like described here, foreign bodies made of other materials can also be seen on radiographs and can also be problematic during imaging. A three-dimensional image allowing determination of the location and size of the foreign body on all three planes is often helpful in the case of ambiguities [43].

The radiographs shown here elucidate the issues surrounding radiography as a subfield in dentistry. Corresponding knowledge of potential foreign bodies is essential even in the case of a prospective comprehensive introduction of software with artificial intelligence for detecting and classifying structures and treatments on panoramic radiographs, which is quite promising in the case of implants, crowns, metallic fillings, and endodontic treatments in jaw segments with teeth [44].

Conflict of Interest

The authors declare that they have no conflict of interest.

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