Computed tomography in the management of orbital infections associated with dental disease

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SUMMARY Two patients developed orbital infection secondary to dental infections. In one patient the infection spread from maxillary premolar and molar teeth to the infratemporal and pterygopalatine fossa and then through the inferior orbital fissure to the subperiosteal space. A subperiosteal abscess in the posterior lateral orbital wall developed, which subsequently spread within the muscle cone. In the second patient infection of an anterior maxillary tooth caused a pansinusitis and unilateral orbital cellulitis. In both patients computed tomographic scanning of the orbit proved valuable in localising the infection and, in one case, planning a surgical approach to the orbit. The infection in both patients responded to treatment, with no permanent visual impairment. Appropriate antibiotics and prompt identification and surgical drainage of orbital abscesses are essential for the preservation of vision in cases of orbital infection.

Although dental infection has been recognised as a source of orbital cellulitis since the time of Hippocrates,¹ attention to this association in the recent ophthalmic literature has been sparse. In the preantibiotic era orbital cellulitis was commonly associated with dental abscesses and maxillary sinus involvement. The widespread use of prophylactic and therapeutic antibiotics has decreased the incidence of ocular complications of odontogenic infections, although occasional cases still occur.²⁻⁵ Orbital cellulitis can often be managed medically; however, surgical drainage is usually necessary if a localised abscess develops in the orbit.^{6,7} Computed tomography has aided in the evaluation and management of orbital lesions,^{8,9} including orbital cellulitis.^{10,11} We describe 2 cases of orbital infections associated with dental disease in which computed tomographic scanning proved useful in patient management.

Case reports

CASE 1

A 30-year-old man had a 4-day history of swelling of

his left upper cheek. With the patient under local anaesthesia incision and drainage of an abscess in the left buccal space were performed. The carious teeth were not removed. He was treated with oral penicillin. The patient returned 2 days later with increased pain and swelling of the left cheek. 30 ml of purulent material was drained from the same abscess. The following day the patient had signs of infratemporal space extension of the infection. He was admitted into the hospital and started on a regimen of 2 million units of intravenous penicillin G every 4 hours. Approximately 3 hours after admission the patient became somnolent; his temperature was 40.5°C (105°F). Decreased abduction of the left eye was noted. The dose of intravenous penicillin was increased to 5 million units every 6 hours, and intravenous nafcillin sodium, 2 g every 6 hours, was added. The morning after admission an ophthalmological consultation was requested.

Ocular examination showed that visual acuity was 6/6 (20/20) without correction bilaterally. The pupils were equal and reactive to light. There was no afferent pupillary defect. 6 mm of left proptosis was present. Diplopia was noted in all fields of gaze except the primary position. Ductions of the right eye were full. In the left eye there was an 80% reduction in abduction and a 50% reduction in adduction,

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Fig. 1 Case 1. Computed tomographic scan of the orbits without contrast medium shows medial displacement of the left lateral rectus muscle (black arrows) by a subperiosteal abscess at the apex of the orbit that extended along the lateral orbital wall. An intraconal abscess with gas (white arrow) and significant left proptosis also are shown.

elevation, and depression. Minimal left inferior conjunctival chemosis was present, but the slit-lamp examination was otherwise unremarkable. Applanation tonometry was normal bilaterally. The findings on dilated ophthalmoscopic examination were within normal limits. Skull and sinus x-ray films revealed a soft-tissue density in the left maxillary sinus. The ethmoidal sinuses were clear.

On the day after admission the patient was given general anaesthesia, and the carious left maxillary, first and second premolars, and first, second, and third molars were removed. Incision and drainage of the left infratemporal space were performed. A left Caldwell-Luc procedure and nasal anastomostomy were performed. The maxillary sinus was noted to be clear. Purulent material was drained from the left buccal and infratemporal spaces, and drains were placed at both sites. Through an external approach a sterile swab was inserted into the pterygopalatine space, and material for cultures was taken. These cultures subsequently grew streptococci and *Bacteroides melaninogenicus* (subspecies *intermedius*). Postoperatively intravenous gentamicin, 80 mg every 8 hours, was added to the preoperative antibiotic regimen of penicillin and nafcillin.

During the next 2 days chemosis and proptosis increased. The patient's left ocular motility was reduced by 90% in all fields of gaze. His temperature intermittently spiked to 39.4°C (103°F). The infratemporal incision continued to drain purulent material. Visual acuity remained unaffected until the fifth day in hospital, when it was noted to decrease to 6/15 (20/50) in the left eye. At this time 8 mm of left proptosis was present. The ophthalmoscopic examination of the left eye showed disc hyperaemia and oedema, with a single retinal haemorrhage. A cotton-wool spot was present along the inferotemporal arcade. Goldmann visual field testing showed a central scotoma in the left eye. Computed

tomographic scan disclosed a left subperiosteal abscess at the apex of the orbit that extended along the lateral orbital wall and a secondary intraconal abscess with gas (Fig. 1). The intraconal abscess was enhanced with the use of intravenous iodinated contrast medium (Fig. 2).

With the patient under general anaesthesia a left subperiosteal approach along the inferolateral orbital wall was made to drain 3 ml of purulent material from the subperiosteal abscess 25 mm from the orbital rim. The maxillary sinus was explored, and a blood clot was removed from the antrum. There was no evidence of infection in the maxillary sinus. The orbit was then decompressed into the maxillary and ethmoidal sinuses by removing portions of the floor and medial wall of the orbit. A lumbar puncture at the completion of the procedure yielded normal findings. Cultures from the subperiosteal abscess grew *Bacteroides melaninogenicus* (subspecies *intermedius*), the same organism previously cultured from the infratemporal fossa and the pterygopalatine fossa. Postoperatively defervescence was achieved with an antibiotic regimen of penicillin, nafcillin, and gentamicin. During the next 2 weeks visual acuity returned to 6/6 (20/20) and visual fields returned to normal. The proptosis also resolved, and the patient had only slight restriction of abduction of the left eye.

CASE 2

A 20-year-old black woman noted pain in the area of her right second maxillary bicuspid tooth 2 days after she lost a dental filling from that tooth. The carious right second maxillary bicuspid was promptly removed by her dentist. The following day she had slight swelling on the right side of her face and pain on moving her right eye. Two days after the tooth extraction she returned to her dentist, and he prescribed oral penicillin for her. The following

Fig. 2 Case 1. Computed tomographic scan with the addition of iodinated contrast material enhances the appearance of gas within the intraconal abscess (white arrow). The scan is at a slightly different level than Fig. 1.

morning she noted swelling of the right eyelid, protrusion of her right eye, and diplopia on vertical gaze. She sought ophthalmic consultation and was admitted to the hospital.

Her past medical history was positive for haemoglobin SC disease with proliferative sickle cell retinopathy in the right eye. Three years previously she had undergone argon laser photocoagulation. The patient also had a long history of asthma for which she was taking bronchodilators, including terbutaline sulphate and theophylline. The patient denied having had any previous sinus problems.

On physical examination the patient was alert and had a temperature of 37.8°C (100.2°F). The right side of her face was swollen. On opening her mouth she experienced right-sided temporomandibular joint pain with slight trismus. A few cervical and preauricular lymph nodes were palpable on the right side. There was no pain on palpation of her frontal or maxillary sinuses. Intraoral examination showed normal healing of the extraction site. There was no palatal or vestibular swelling, although the vestibule was tender to palpation. No evidence of an oral-antral communication was observed.

Ocular examination disclosed a visual acuity of 6/6 (20/20) in both eyes. Her pupils were equal and reactive to light without an afferent pupillary defect. Duction testing of the right eye showed reduction of abduction and adduction by 20% and reduction of up and down gazes by 50%. Diplopia was present on vertical gaze. She had 6 mm of right proptosis. External examination demonstrated moderate swelling and erythema of the right eyelids. The conjunctiva was normal. Slit-lamp biomicroscopy and applanation tonometry examinations were unremarkable. A normal disc and macula were noted on ophthalmoscopic examination of the right eye. In the temporal periphery an elevated, fibrous, nonperfused sea fan was visible. Argon laser photo-

coagulation scars were evident. The fundus of the left eye showed evidence of nonproliferative sickle cell retinopathy, with a few scattered sunbursts and iridescent spots.

The patient's haematocrit level was 40%. The white blood cell count was $22.4 \times 10^9/l$, with 94% polymorphonuclear leucocytes, 2% band cells, 3% lymphocytes, and 1% monocytes. Sinus x-ray films demonstrated bilateral opacification of the frontal, sphenoidal, and ethmoidal sinuses. The left maxillary sinus showed mucosal thickening. There was an air fluid level in the right maxillary sinus. Periapical dental x-ray films of the extraction site showed no evidence of tooth fragments; however, the apex of the extraction site was in close proximity to the maxillary sinus. Blood and nasal discharge cultures showed no growth. The patient was treated with intravenous ampicillin, 1 g every 6 hours, and intravenous oxacillin, 1 g every 4 hours. She was also put on a regimen of nasal decongestants, postural drainage, and warm compresses to the face. The day after admission she showed no improvement. A computed tomographic scan of the orbits was obtained. It showed soft-tissue swelling posterior to the orbital septum in the area of the right medial rectus muscle without definite evidence of abscess formation (Fig. 3). On the third day the patient's fever abated and she noted marked relief in pain. Objectively there was some improvement in ocular motility. After 5 days of parenteral antibiotics the patient's ocular motility returned to normal. Lid swelling and proptosis were decreased. Repeat sinus x-ray films revealed resolution of the air fluid level of the right maxillary sinus. The parenteral antibiotics were discontinued, and the patient was treated with oral oxacillin, 500 mg 4 times a day. On follow-up examination one week after discharge ocular motility was normal and there was complete resolution of proptosis.

Fig. 3 Case 2. Computed tomographic scan of the orbits without contrast medium shows soft tissue swelling within the right orbit in the region of the right medial rectus muscle (arrow). Both ethmoidal sinuses are opacified, and right proptosis is shown.

Discussion

Although the use of antibiotics has decreased the incidence of orbital complications of odontogenic infection, dental disease may still cause infections,^{6,12} including preseptal cellulitis, orbital cellulitis, orbital abscess, subperiosteal abscess, and cavernous sinus thrombosis.

Acute odontogenic infection may spread through tissue planes and venous channels to involve the orbit. The routes of infectious extension may be summarised as follows: (1) The roots of maxillary premolar and molar teeth may lie very close to the maxillary sinus. Maxillary sinusitis may result from extension of maxillary molar or premolar infection or from perforation of the sinus floor during extraction of diseased maxillary teeth. Sinusitis may then extend into the orbit to cause orbital cellulitis.¹ (2) Infection of maxillary incisors or canines may spread through local tissue planes over the maxilla, resulting in swelling of the upper lip, canine fossa, and periorbital tissue. Retrograde spread into the orbit may then occur through the valveless anterior facial, angular, and ophthalmic veins.⁵ (3) Infection of anterior maxillary teeth may also spread as a subperiosteal abscess to the anterior surface of the maxilla to involve the orbit.¹ (4) Infection of the posterior maxillary teeth, most commonly the third molar, may spread posteriorly into the pterygopalatine and infratemporal fossae. The infection may then extend into the orbit through the inferior orbital fissure.^{1,5,13}

Our cases illustrate 2 of these mechanisms of spread. Patient 1 had an infection of maxillary molar and premolar teeth that spread to the infratemporal space and pterygopalatine fossa. The infection presumably gained access to the orbit through the inferior orbital fissure. A subperiosteal abscess developed in the posterior lateral orbital wall, which subsequently spread within the muscle cone.

Bacteroides melanogenicus (subspecies *intermedius*), a gas-forming organism, was cultured from the infratemporal fossa, pterygopalatine fossa, and from the subperiosteal abscess. In patient 2 infection of an anterior maxillary tooth with a root in close proximity to the maxillary sinus resulted in acute pansinusitis and right orbital cellulitis. No organism was recovered from blood or nasal cultures.

Infections of periorbital and orbital tissues are classified according to their location relative to the orbital septum.¹⁴ The orbital septum separates the orbital contents from the lids and acts as a barrier to the spread of infection from the skin into the orbit. Preseptal cellulitis involves the tissues anterior to the septum, whereas orbital cellulitis involves those tissues posterior to the septum. It has been shown that orbital cellulitis may be complicated by orbital or subperiosteal abscesses in more than 20% of cases.⁹ A subperiosteal abscess may develop from direct extension of suppuration into the tissue plane between the periosteum and the orbital wall. An orbital abscess may form by the consolidation of infection within the orbit or from the rupture into the orbit of a subperiosteal abscess.

It may be difficult sometimes to distinguish between these entities on clinical grounds alone. All are associated with warm, erythematous, swollen lids with varying amounts of conjunctival chemosis. However, proptosis, restriction of ocular motility, pain on ocular movement, an afferent pupillary defect, decreased visual acuity, disc oedema, choroidal folds, and retinal venous stasis distinguish infections within the orbit from preseptal cellulitis.

It is important to identify cases with orbital or subperiosteal abscess formation, because prompt surgical drainage in these cases is usually necessary to prevent permanent visual loss. Computed tomography is an established radiographic procedure that can aid in the differentiation of these entities.^{10,11}

Preseptal cellulitis is characterised on computed tomographic scanning by the presence of inflammation localised in the tissues anterior to the orbital septum without intraorbital disease. Orbital cellulitis can be demonstrated as an obliteration of fat shadows within the muscle cone or the presence of soft tissue swelling within the orbit. Computed tomographic examination of a patient with a subperiosteal abscess shows a mass lesion located between the orbital wall and the displaced periosteum. The periosteal wall of the abscess may at times be more clearly defined with the use of intravenous iodinated contrast medium. An orbital abscess appears as a localised inflammatory mass within the orbital tissues. Gas may be demonstrated within the abscess, arising either from gas-forming bacilli or from a communication of the abscess with an adjacent paranasal sinus. An abscess may be outlined by the use of contrast enhancement.

Computed tomographic scanning proved useful in both of our patients. In case 2, after no improvement was noted with intravenous antibiotic therapy, the computed tomographic scan revealed orbital cellulitis and ruled out an orbital abscess. In case 1 the computed tomographic scan demonstrated a subperiosteal abscess in the posterior lateral orbital wall and an intraorbital abscess with gas. Timely direct drainage of the subperiosteal abscess and decompression of the orbit resulted in resolution of proptosis, recovery of visual acuity, improvement of ocular motility, and return of the visual fields to normal.

Axial computed tomographic scans of the orbit are also of value in delineating the anatomical association among the orbits, the paranasal sinuses, and intracranial structures. Computed tomographic scanning can identify cerebral complications such as cerebritis, brain abscess, and epidural infection. In addition axial views allow comparison of both orbits to detect minimal significant differences. This view is also useful to evaluate proptosis and displacement of the globe, muscle cone, or optic nerve.

Prior to the use of computed tomographic scanning identification of the site of abscess formation was primarily accomplished by localising inflammatory signs and the direction of displacement of the globe.¹⁴ However, these methods have limitations, especially when proptosis is axial. Computed tomographic scanning can precisely localise abscesses, which allows the correct surgical approach to be taken for drainage.

The most frequently isolated organisms in orbital infections in adults include *Staphylococcus aureus*, *Streptococcus pyogenes*, and *Str. pneumoniae*.^{14 15} In addition *Haemophilus influenzae* is a very commonly isolated pathogen in children.¹⁶ Other aerobic Gram-negative organisms are rare. A wide variety of

anaerobic or microaerophilic organisms, particularly *Bacteroides* species, have been implicated in orbital cellulitis.

The presence of gas in association with orbital infections may aid in the identification of the causative organism. The differential diagnosis of gas-producing organisms includes anaerobic bacteria such as *Clostridia*, *Bacteroides*, anaerobic streptococci, and anaerobic micrococci. Aerobic enterobacteria such as *Proteus*, *Klebsiella*, and *Escherichia coli* can also produce gas.^{17 18} In addition defects in the orbital walls produced by infection of the paranasal sinuses may allow air from the respiratory tract into the orbit, simulating gas produced by gas-forming organisms.¹⁹

Antibacterial therapy should be based on the organisms most likely to be encountered. In cases of orbital infection with associated dental or sinus infection initial treatment with penicillin and a penicillinase-resistant antibiotic is recommended. The therapeutic regimen can be altered when the results of bacterial cultures and tests of antibiotic sensitivities are available.

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