Severe odontogenic infections

IC Uluibau,* T Jaunay,† AN Goss‡

Abstract

Background: Severe odontogenic infections are serious potentially lethal conditions. Following the death of a patient in the authors' institution this study was initiated to determine the risk factors, management and outcome of a consecutive series of patients.

Methods: All patients admitted to the Royal Adelaide Hospital under the care of the Oral and Maxillofacial Surgery Unit with odontogenic infections in calendar year 2003 were investigated. Detailed information relative to their pre-presentation history, surgical and anaesthetic management and outcome was obtained and analysed.

Results: Forty-eight patients, 32M, 16F, average age 34.5, range 19 to 88 years were treated. All presented with pain and swelling, with 21 (44 per cent) having trismus. Forty-four (92 per cent) were as a result of dental neglect and four (8 per cent) were regular dental patients having endodontic treatment which failed. Of those known to have been treated prior to presentation, most had been on antibiotics. Most patients had aggressive surgical treatment with extraction, surgical drainage, high dose intravenous antibiotics and rehydration. The hospital stay was 3.3 (range 1-16) days. Patients requiring prolonged intubation and high dependency or intensive care (40 per cent) had longer hospitalization. No patient died and all fully recovered.

Conclusion: Severe odontogenic infections are a serious risk to the patient's health and life. Management is primarily surgical with skilled anaesthetic airway management. Antibiotics are required in high intravenous doses as an adjunct and not as a primary treatment.

Key words: Odontogenic infection, antibiotics, airway.

Aust Dent J 2005;50 Suppl 2:S74-S81

INTRODUCTION

Severe odontogenic infections as a serious illness or cause of death have been known since antiquity.[1] In the modern surgical but pre-antibiotic era odontogenic infections were associated with a significant death rate in the range of 10-40 per cent.[2] With the advent of penicillin and the subsequent developments of a range of antibiotics, odontogenic infections, along with many other infections, became considered as easily managed conditions. However, in the last 10 to 15 years there has been a progressive return of serious antibiotic resistance.[3] This has been insidious and there has been a tendency for serious odontogenic infections to be dismissed in hospital practice as simple dental problems. The authors are aware of at least two deaths of patients whilst under treatment for odontogenic infections in major Australian teaching hospitals in the last few years. One was at the authors' institution and inspired this study.

Odontogenic infections arise either from pulp death, secondary most commonly from dental decay, alternatively they commence in the pericoronal tissues. In both instances they are of oral microbial origin. Dependent on the type, quantity and virulence of the micro-organisms they may spread into the maxilla or mandible and then into the surrounding face, jaws or neck. Although there are many other causes of head and neck infection, odontogenic infections are the most common type. Huang *et al.*[4] found 50 per cent of 185 cases of deep neck infections were odontogenic in origin, Bridgeman *et al.*[5] found 53 per cent in their 107 cases, Bross-Soriano *et al.*[6] 89 per cent in their 121 cases and Juang *et al.*[7] 86 per cent in their study of 14 true Ludwig's angina cases.

Odontogenic infections are always polymicrobial and are a mix of aerobic, facultative anaerobes and strict anaerobes. The most common micro-organism in dentoalveolar infection is *streptococcus viridans*.[4] Generally, the more skilled and intensive the microbiologic study, the greater the range and type of bacteria demonstrated. Sakamoto *et al.*[8] isolated 112 bacterial strains, with an average of 4.86 strains per patient from 23 dentoalveolar abscesses. Only 28 per cent were aerobes or facultative anaerobes with 72 per cent being strict anaerobes. Heimdahl *et al.*[9] in their study found that 88 per cent of the micro-organisms were anaerobic. They also showed that the more severe and extensive the infection the more common were anaerobes. This was statistically significant for gram-negative rods ($p<0.05$). *Streptococcus milleri* were more common, but not statistically so in severe infections. Kuriyama *et al.*[10] demonstrated 664 different strains from their study of 106 cases. There is consensus in all these studies that the bacteria most commonly found in odontogenic infections are *streptococci* which are aerobes, and *peptostreptococci*, pigmented and non-pigmented *prevotella* and *fusobacterium*, all of which are anaerobes.

Anatomical factors play a key role in the presentation of bacterial infection, once they have spread beyond the confines of the jaws. Spread of the

*Postgraduate Student, Oral and Maxillofacial Surgery Unit, Faculty of Health Sciences, The University of Adelaide.
†Registrar, Oral and Maxillofacial Surgery Unit, Faculty of Health Sciences, The University of Adelaide.
‡Professor and Director, Oral and Maxillofacial Surgery Unit, Faculty of Health Sciences, The University of Adelaide.

infection tends to follow the lines of least resistance, which are dictated by the bone and periosteum, muscle and fascia. This was well demonstrated in 1938 by Grondinsky and Holyoke[11] who used dyed gelatin injections to determine the path of least resistance between the fascial planes. This and other anatomical studies form the basis of the standard anatomical spaces of the head and neck.[12,13]

The remaining major factor in the nature of the untreated progression of odontogenic infections is host resistance or its impairment by systemic disease. Immunocompromised states such as HIV/AIDS, haematological neoplasia or systemic diseases such as diabetes are risk factors in the fulminating spread of infection.[14-16]

Severe odontogenic infections are an end result of an initially long and slow disease process. The micro-organisms involved in dental decay take months if not years to reach the dental pulp to cause pulp necrosis and then periapical abscess. Partially erupted teeth are intermittently symptomatic before serious symptoms ensues. Most patients have had multiple warning signs and symptoms prior to the onset of symptoms. Bridgeman *et al*.[5] in their study of 107 Australian patients seen over a 57 month period found that all (100 per cent) of the patients had experienced pain prior to presentation. Commonly this had been intermittent and the patient had failed to act or obtained inadequate primary treatment. The sudden onset of swelling in 105 (98 per cent) of their patients within the preceding hours or days was the actual trigger for patients to seek specialist hospital attention. Forty-six per cent of their patients had reached the stage of trismus or difficulty in opening their mouth. By this time the infection had spread well beyond the confine of the jaws. These patients clearly had severe, clinically significant infection.

The principle of management of severe odontogenic infections has been known for centuries; extract the tooth and drain the pus. This was described by Hippocrates[1] and is reinforced in the modern surgical but pre-antibiotic era.[2] In the antibiotic era the use of antibiotics, intravenous fluids to re-hydrate the patient and appropriate pain management have been well described[4-7,12] and taught to dental and medical undergraduates for decades.[17-21]

The primary practitioner, whether dental or medical, has a key role in the management of odontogenic infection. They can treat patients with antibiotics alone, institute the known correct management or refer to a specialist oral and maxillofacial surgeon or other dental specialist. Initially antibiotics may appear to work, but if the patient does not proceed to definitive management the problem will recur with increased severity. Antibiotics are a predisposing factor in most published series of severe infections.[4-7] A different source of odontogenic infection may occur from dental treatment when practitioners try to conserve a tooth. It would be in the best interests of the patient to recognize that conservative management has been unable to resolve the presenting problem and extract the involved tooth.

Death is the most serious complication of severe odontogenic infections with a reported incidence of zero,[5-7] 1.6 per cent[4] and 23 per cent.[22] This latter small study[22] was confined to patients with severe necrotizing infections. Death was either from acute airway obstruction, which can occur at any age and usually in fit patients, to multi-organ failure in medically compromised, usually older patients.

This study reviews a consecutive series of severe odontogenic infections admitted to a major metropolitan hospital in a 12-month period. Particular emphasis was placed on patient and clinician actions prior to presentation, definitive management and the outcome.

MATERIALS AND METHODS

Medical records were obtained of all patients admitted to the Royal Adelaide Hospital, Adelaide, South Australia, under the care of the Oral and Maxillofacial Surgery Unit with a primary diagnosis of acute infections in the period 1 January 2003 to 31 December 2003. The inclusion criteria for this study were all patients with odontogenic infections which had spread beyond the confines of the jaws and who were severely ill to warrant admission to hospital for surgical management. No patient who was admitted to hospital meeting these criteria was excluded. Patients who had spreading infections, who did not require hospitalization and were treated as outpatients, were excluded.

A detailed database of the patient demographics, presentation and full details of management (including complications) was recorded. This was maintained on a non-networked personal computer and simple analysis performed. The corresponding number of patients admitted with odontogenic infections in 1993 was determined. This study was performed in accordance with the internal audit requirements of the Royal Adelaide Hospital.

RESULTS

Eighty-eight patients were admitted with head and neck infections of which 48 (55 per cent) had an odontogenic origin. Thirty-nine (81 per cent) were of pulpal origin and nine (19 per cent) of pericoronal origin. The patient demographics are shown in Table 1. The medical status of the patients is presented in Table 2. Only those conditions which had contributed to the presentation were included.

Table 1. Patient demographics, n = 48

Age	Mean 34.5 years (Range 19 to 88 years)	
Gender	32 M (67%), 16F (33%)	
Race	Caucasian	36 (75%)
	Aboriginal	8 (17%)
	Other	4 (8%)
Social	Government Health Card	33 (67%)

Table 2. Pre-existing medical problems, n = 48

Fit and well		20 (42%)
Medically unwell		28 (68%)
Mental illness		9 (19%)
• Schizophrenia	5 (10%)	
• Severe depression	4 (9%)	
Substance abuse		7 (15%)
• Alcohol	5 (10%)	
• IV drugs	2 (5%)	
Diabetes mellitus		4 (8%)
• NIDDM	3 (6%)	
• IDDM	1 (2%)	
Immunosuppressed		1 (2%)
• Autoimmune Hepatitis		
Drug allergy		5 (10%)
• Penicillin	1 (2%)	
• Erythromycin	1 (2%)	
• Narcotics	2 (4%)	
• Chloroquinone	1 (2%)	

Table 3. Treatment prior to presentation with a severe odontogenic infection, n = 48

Patients known to have received prior treatment		16 (33%)
• Antibiotic only		7 (15%)
Medical	5 (10%)	
Dental	2 (4%)	
• Dental treatment		8 (17%)
Temporary filling	1 (2%)	
Endo started	5 (10%)	
Extraction	2 (4%)	
• Self treatment		1 (2%)
Attempted extraction		

The treatment history in the days or weeks prior to the onset of the acute presentation is presented in Table 3. Only accurate verifiable information is recorded. It is noteworthy that many of the patients were very vague about their history although most agreed that they had experienced intermittent symptoms, usually pain, for some months. Similarly, they were vague about whether they had sought or received any treatment. About half indicated that they probably had at least one course of antibiotics prior to the acute onset of symptoms.

Of the eight patients who had dental treatment, four were casual attendees and four were regular patients at private general dental practices. In this latter group all four were employed Caucasians having endodontic treatment. All had been placed on a multiple course of antibiotics. The attempted self-extraction was by a patient with a long history of mental illness.

The findings on presentation for treatment are presented in Table 4. Superficial space involvements are

Table 4. Clinical finding on presentation for treatment, n = 48

Pain	48 (100%)
Swelling	48 (100%)
Trismus	21 (44%)
Superficial	27 (56%)
Deep neck	21 (44%)

Table 5. Space involvement, n = 48

Number of spaces involved	
• 1	26 (54%)
• 2	11 (22%)
• 3	7 (15%)
• 4	2 (4%)
• 6	1 (2%)

those away from the airway, that is the canine or buccal space. Deep neck infection involves the spaces around the upper airway, primarily the submandibular space. Commonly, only one space was involved. The three patients with multiple space involvement were true Ludwig's angina patients with bilateral whole neck involvement. The space involvement is presented in Table 5 and illustrated in Figs 1a, 1b and 1c.

The surgical management is set out in Table 6. In the five patients who had no extractions the tooth had been removed within the last week for three, and for two of the patients they refused extraction. In the eight where drainage did not obtain pus, these by definition have cellulitis. The standard hospital protocol is benzylpenicillin 1.2g IV six hourly with metronidazole 500mg IV 12 hourly, which is maintained until the

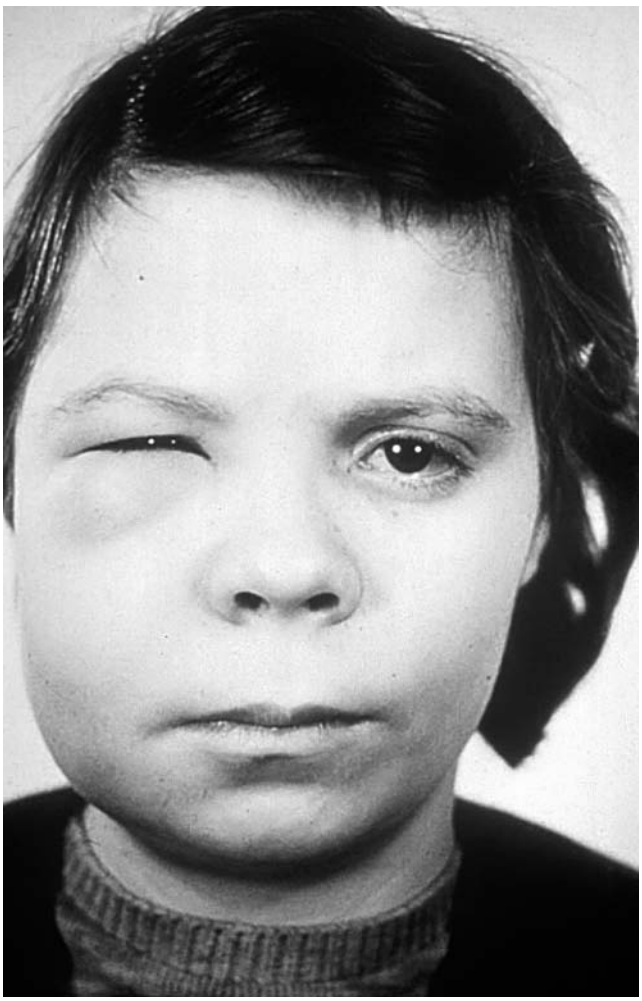

Fig 1. Different presentations of odontogenic infections

Fig 1a. Superficial. Right canine fossa and buccal space infection. Low airway risk. Note patient was not in the 2003 series but is an archival illustration.

Fig 1b. Deep. Right submandibular space abscess. Note the patient is intubated.

Fig 1c. Deep bilateral Ludwig's angina. Note multiple drains and intubation.

patient is fit to be discharged. This is followed by oral amoxicillin 500mg eight hourly for five days. Cephazolin 1g IV six hourly is used for patients suspected to be allergic to penicillin or who showed penicillin resistance. Non-protocol antibiotic regimens were used for nine cases, usually by continuing the antibiotic regimen commenced in other institutions. No statistically significant outcomes resulted from the different antibiotic regimens. The details of the antibiotic regimens used are presented in Table 7.

Table 6. Surgical management, n = 48

Three patients had extractions in the week prior and two patients refused extraction.

Anaesthesia		48 (100%)
• General	42 (87%)	
• LA/sedation	6 (13%)	
Extractions		43 (90%)
Drainage		47 (97%)
• Extra-oral	39 (81%)	
• Oral only	9 (18%)	
• Via socket only	1 (2%)	
Pus obtained		38 (79%)
Serous only		8 (16%)
Antibiotics		48 (100%)

Table 7. Antibiotic regimens employed, n = 48

Type	Dose	Route	Frequency	N	Comments
Benzylpenicillin	1.2g	IV	6 hourly	34 (70%)	Standard
Metronidazole	500mg	IV	12 hourly		regimen
Cephazolin	1g	IV	6 hourly	8 (17%)	Two
Metronidazole	500mg	IV	12 hourly		patients known allergy
Benzylpenicillin	1.2g	IV	6 hourly		Culture results
Changed to					showed
Cephazolin	1g	IV	6 hourly	3 (6%)	resistance
Plus					to penicillin
Metronidazole	500mg	IV	12 hourly		
Amoxycillin	1g	IV	8 hourly	2 (4%)	Commenced
Metronidazole	500mg	IV	12 hourly		on this at other hospital
Benzylpenicillin	1.2g	IV	12 hourly	1 (2%)	Superficial
		IV			infection

Table 8. Post-operative hospital course, n = 48

Returned to ward		29 (60%)
• LA/Sedation	6 (13%)	
• GA extubated	23 (47%)	
Remained intubated		19 (40%)
• ICU*	15 (31%)	
• HDU**	4 (8%)	
Length of hospitalization		3.33 days (1-16 days)
• Returned to ward	1.5	
• HDU**	3.0	
• ICU*	6.0	

*ICU – Intensive Care Unit.
**HDU – High Dependency Unit.

The post-operative course is presented in Table 8. At the end of the surgical procedure there was consultation between the surgeon and anaesthetist about the risk of airway obstruction. If considered a low risk the patient was extubated, observed for a short time in the recovery facility and then returned to the ward. The four patients who went to high dependency were kept intubated for several hours whilst peak swelling occurred and were then extubated. The 15 patients who primarily went to intensive care all had at least 24 hours of intubation, with two having more than five days. One developed pneumonia whilst intubated which was successfully treated with prolonged antibiotics. One developed methicillin resistant *Staphylococcus aureus* in the intensive care

unit environment. Post-operative steroids are advocated by some surgeons for intubated patients. These take several hours to have an effect and increase the risk of further bacterial spread. No patient who was extubated at the end of operation was given steroids. Of the 19 intubated patients; five had no steroids, five had a single dose and eight had more than one dose. One patient was already on steroids for auto-immune hepatitis. There were no statistical differences between these groups for hours of intubation, or length of ICU or hospital stay. There was a weak statistical correlation to the number of spaces involved and the use of steroids ($p<0.037$). The one patient who developed pneumonia was on steroids.

In two of the 23 cases extubated and returned to the ward, complications occurred and the decision reversed. One, whilst in stage 1 (early) recovery, developed stridor and other signs of breathing difficulty. Accordingly, they were re-anaesthetized, re-intubated and admitted to intensive care. The second patient became progressively worse with increased pain, swelling, trismus and fever. A CT scan showed further pus collection, they were re-anaesthetized and further incision and drainage performed. By now the patient had considerable neck swelling and the airway was compromised. The airway was secured by a tracheostomy. Post second operation the patient went to intensive care.

The post operation destination had a significant effect on length of hospital stay which in turn has an effect on hospital resources. Those who were extubated and returned to the ward were fit for discharge, on average, in 1.5 days. Those who required intensive care on average were discharged after six days. The longest stay was 16 days.

The effect of delay in presentation to hospital and airway risk was analysed. Those patients who delayed presentation for more than one week were significantly ($p<0.01$) more likely to have a spreading deep neck infection. Those patients who had a deep neck infection were significantly ($p<0.01$) more likely to require intensive care admission. Fit and well patients, when compared to those with one co-morbidity, had similar hospital stays. Those with two co-morbidities, for example medical and mental illness or similar pairs, had a significantly increased hospital stay ($p<0.01$).

The incidence of severe infections treated by the Oral and Maxillofacial Surgery Unit in 2003 was 44 per million. In 1993 the incidence was approximately 32 per million.

DISCUSSION

This study shows that severe and potentially life-threatening odontogenic infections were treated on a weekly basis in a major Australian hospital. All required high intensity specialist surgical and anaesthetic management and 31 per cent required high level intensive care management. All resolved without significant sequelae and there were no deaths. In general, these findings were similar to other large Australian series in which 56 pulpal or pericoronal causes were treated in 57 months.[5] Comparison of the two studies, which were performed a decade apart, supports the anecdotal view that severe odontogenic infections are on the increase. The inclusion criteria were similar but the Melbourne series had 56 as compared to 48 cases gathered from a much larger population of 3.5 million (Melbourne) to 1.1 million (Adelaide). The Royal Melbourne Hospital services about one-third of the Melbourne population, whereas the Royal Adelaide is the sole oral and maxillofacial service in South Australia. This represents a Melbourne incidence in the early 1990s of approximately 34 cases per million per year and further supports the view that serious, life-threatening odontogenic infections are uncommon but increasing.

Spreading odontogenic infections should be readily preventable by routine dental treatment. In this study only four (16 per cent) of the patients involved were regular dental attendees. Thus patient responsibility, or rather irresponsibility, toward their own dental care is a key factor. Sixteen (34 per cent) of the patients had problems with major substance abuse or mental illness which are associated with poor health practices. They are also associated with xerostomia which in itself contributes towards poor oral health.

The majority of the patients admitted they had negative attitudes toward oral health, citing fear, phobia or problems with expense. It was attempted to explore these issues in this study but most patients were vague or poorly responsive. This additional information was sought during the patients' hospitalization phase either when the patient was being admitted, when they were seriously ill or when they were being discharged and keen to go home.

Patients with Government Concession Cards (67 per cent), either from age, disability or unemployment were over represented in this study as compared to the South Australian Community (40 per cent). In South Australia there is a well-developed public dental service for health care cardholders with minimal co-payments so cost is not an issue. Of the 440 000 eligible patients in South Australia in 2002 only 66 000 (15 per cent) sought dental care and of these only 13 000 (20 per cent) sought regular conservative dental treatment. No patient in this study was on a public dental waiting list, although some had intermittently sought emergency dental treatment.

Only 16 (33 per cent) of the patients were known to have had treatment in the weeks prior to presentation with a severe infection. Of these, seven (15 per cent) had been put on antibiotics by general medical practitioners. Six of these patients felt that this was the definitive treatment and all denied any knowledge that they needed dental treatment. Two (4 per cent) patients had presented to their local private dentist with a swollen face and trismus and were not seen immediately. One patient was advised by reception staff

Fig 2. CT imaging of the airway in patients with deep odontogenic infections (a, b and c same patient). This patient had a left submandibular infection and was being treated at a peripheral hospital with antibiotics alone. He developed airway embarrassment and was intubated prior to air evacuation to Royal Adelaide Hospital.

Fig 2a. Nasopharynx – obstructed.

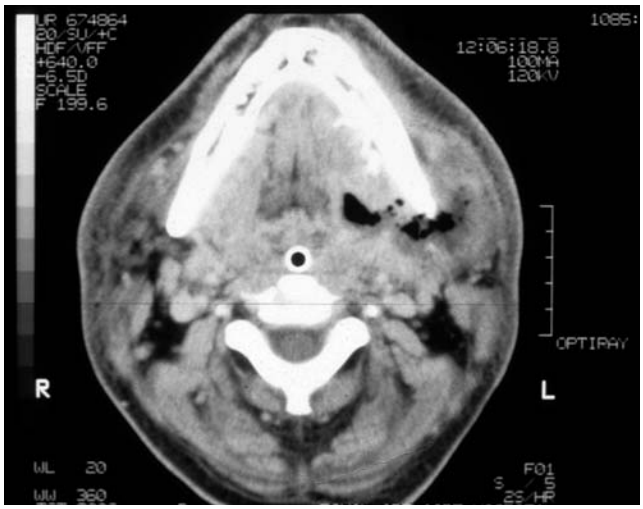

Fig 2b. Oropharynx – swelling tight against the orotracheal tube. Abscess space on the patient left, image right, mandible.

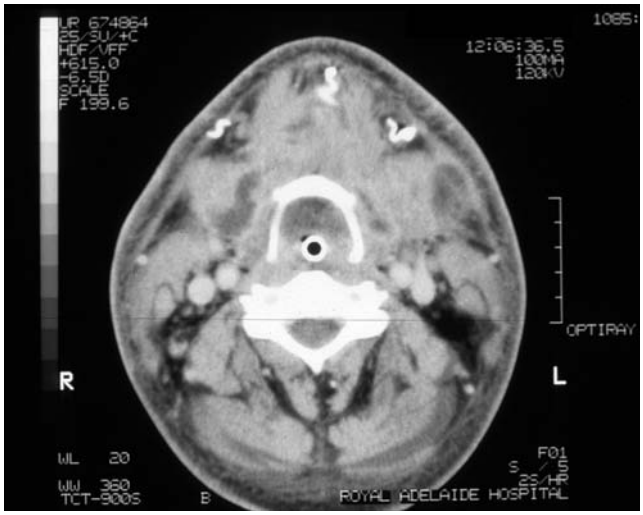

Fig 2c. Hypopharynx at the level of the hyoid bone – obstructed.

Fig 2d. Oropharyngeal level of patient with Ludwig's angina (Fig 1c). The airway is obstructed over a considerable length and the anatomy distorted. This makes reintubation or tracheostomy difficult.

that the dentist was busy and would not be able to see the patient for over one week. The patient was offered a script for antibiotics and at no stage was seen by the dentist. Two days later the patient was in intensive care. Prescribing antibiotics without seeing the patient in need is unethical and arguably negligent treatment.

Four (8 per cent) patients were receiving current, regular dental care. They had not responded to multiple endodontic debridements and courses of antibiotics. All four patients and their dentists believed it was essential to save the tooth. Two of these patients declined to consent to tooth extraction even when they were admitted to hospital severely ill. These were treated with drainage with further endodontic treatment. It is understood that one of the teeth has since been extracted. This raises an interesting question: which is more important, one tooth, your health or potentially your life?

The key precipitant to presentation to hospital for management was pain and swelling. Twenty-one (44 per cent) of patients had trismus on presentation. This presenting sign is commonly underestimated by patients and dentists as a jaw problem. All patients with trismus of odontogenic infection origin primarily have an upper airway problem (Figs 2a-2d). Several patients noted they could not lie down as they felt like choking. Thus all patients with infection-related trismus should be carefully evaluated for signs of upper airway embarrassment, tongue elevation, stridor, difficulty in swallowing saliva and decreased air intake. This is a medical emergency and should be immediately sent to hospital. Under ambulance retrieval criteria, this is a priority case. Some presented initially to other hospitals but all were directed to the Oral and Maxillofacial Surgery Unit at the Royal Adelaide Hospital. A standard hospital protocol for such patients has been developed by the Oral and Maxillofacial Surgery Unit with the Otorhinolaryngology and Anaesthetic Departments.[23] (Copy available on request).

Essentially, the protocol involves assessment of the airway with immediate intubation if indicated. If there is uncertainty the upper airway is inspected by direct laryngoscopy. Intravenous access is obtained and the patient rehydrated. Large doses of intravenous antibiotics are commenced. Analgesia is not given until the airway is assessed and secure. Imaging is obtained once the patient is stabilized. Placing a patient supine in a CT scanner with an uncontrolled airway is inviting disaster. Once fully assessed and stabilized the patient is an emergency priority case for operation. Prior to operation, the surgeon and anaesthetist should discuss airway management. Superficial anterior infection may be safely managed under local anaesthetic and sedation. A fibre optic intubation is performed if there is trismus, a possibility of pus in the airway or deformity of the jaw or airway. A careful examination under anaesthesia is performed, any diseased teeth are extracted and all involved spaces are explored and drains placed. On completion of surgery the surgeon and anaesthetist discuss the degree of swelling expected and the state of the airway. A joint decision is then made as to whether the patient should be extubated and returned to the ward or kept intubated in high dependency or intensive care. If in doubt the patient should be left intubated.

The decision to extubate or leave patients intubated had important consequences for the length of hospitalization. This in turn has cost implications to the public health budget. However, patient safety is paramount. One patient in the series was extubated but rapidly developed airway problems and was reintubated. Reintubation is difficult and in these circumstances the surgical team must be on standby to perform a tracheostomy. Tracheostomy was also required for another patient in the series with an aggressive infection which failed to respond to initial surgical treatment. The two patients known to have died recently in major Australian teaching hospitals from odontogenic infections both died a few hours post-operative from acute upper airway obstruction. Both had reintubation and tracheotomy performed by experienced resuscitation teams in a hospital environment and were young and fit with no contributing medical problems.

An issue which is commonly raised is whether the patient has a cellulitis, in which case some suggest drainage should not be performed or an abscess, where drainage should be performed. In our view, this is a myth for both have bacterial swelling. Whether or not pus is present is partly dependent on the stage of this disease, the micro-organism involved or the degree of host resistance. On review, the issue of cellulitis being managed clinically differently is a carry over from the pre-antibiotic era.[17] Then there was a risk that more extensive surgical intervention could make the condition worse. In this series 38 (79 per cent) had an abscess with pus drainage and eight (16 per cent) had a cellulitis as only serous fluid was obtained. All were treated the same with an equal outcome. The difference between cellulitis and abscess cases is no longer clinically relevant: both should be drained.

Forty-seven (98 per cent) of the patients had intravenous antibiotics for both aerobic and anaerobic bacteria. All patients had bacterial investigations which reported mixed bacterial colonies consistent with normal oral flora. No unusual bacterial infections were found in this series. One patient was allergic to penicillin. In the past the patients had multiple courses of antibiotics including several episodes for the current dental problems. One patient developed MRSA whilst in intensive care. This is an environmental risk for all patients in intensive care but this patient had also received many episodes of antibiotics in their life. In this series no patient died and all recovered satisfactorily.

CONCLUSIONS

Severe odontogenic infections appear to be on the increase. They are mainly the result of prolonged patient neglect of routine dental problems although sometimes they are the result of unsuccessful dental treatment. Antibiotics are an essential adjunct in surgical management but antibiotics used alone may contribute to the worsening of the condition. Odontogenic infection in advanced stages, even with appropriate treatment, is a potentially fatal condition.

ACKNOWLEDGEMENTS

The authors acknowledge the involvement of the staff of the Oral and Maxillofacial Surgery Unit, Otorhinolaryngology Unit, Anaesthetic Department, Intensive Care and High Dependency Units and the ward staff of the Royal Adelaide Hospital in the management of the patients.

This paper is dedicated to the memory of our patient who died as a result of an odontogenic infection.

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Address for correspondence/reprints:
Professor Alastair N Goss
Oral and Maxillofacial Surgery Unit
Faculty of Health Sciences
The University of Adelaide
Adelaide, South Australia 5005
Email: oral.surgery@adelaide.edu.au