Case Series

Management of fascial space infections using ultrasonography as a surgical guide for drainage - A case series

ABSTRACT

Fascial space infections are common emergencies presented to a maxillofacial surgeon. Space infection requires early diagnosis and prompt management. When left untreated, space infection spreads and involves not just one space, but also its adjacent spaces. Abscess in the head and neck region are treated by surgical incision and drainage, along with antibiotics and removal of the causative factor. The surgical incision and drainage of an abscess, if carried out based on physical examination may result in, excessive pain, tissue trauma, unnecessary extensive incisions, excess time and failure to locate and evacuate the abscess fluid. To avoid all such complications, ultrasonography is not only an invaluable diagnostic tool but also aids in ultrasonography guided drainage of fascial space infections.

Keywords: Drainage, fascial space infections, incision, ultrasonography, ultrasound guided drainage

INTRODUCTION

Infections involving the fascial planes and spaces of the head and neck are termed as fascial space infections. The infections spread in an organized manner through the loose connective tissue and it tends to accumulate in the potential spaces around the head and neck. These infections are common emergencies which can result in significant morbidity with potential mortality.[1]

Evaluation of the stage of infection is pivotal. Cellulitis can be treated by antibiotics conservatively, but abscess requires comprehensive treatment including incision and drainage along with antibiotics. Fascial space infections have been routinely evaluated by physical examination and with diagnostic tools such as radiographs, but the abscesses of the deep subcutaneous layer may be difficult to locate. Blind surgical drainage without proper evaluation usually results in inadequate drainage, tissue trauma, unnecessary extensive incisions, excess time, pain, and failure to locate and evacuate the abscess cavity.[2]

Ultrasonography (USG) is an effective imaging modality in evaluating the anatomic location of fascial space infections

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and highly predictable in determining the stage of infection. USG is quick, non-invasive, sensitive, widely available, affordable, pain less and is relatively a new diagnostic aid in dentistry. USG is very sensitive in detecting fluid collection. The presence of blood vessels and strictures in the blood vessels can also be evaluated by USG with color doppler. Follow-up evaluation can be repeatedly carried out as there is no radiation exposure.[3,4]

The conventional treatment for fascial abscess is intraoral or extraoral approach of incision and drainage. The intraoral approach has its limitations of poor visualization and may cause airway compromise from persistent bleeding or purulent discharge. Extra oral incision and drainage usually require incisions and exploration, which predisposes patients to a risk for neurovascular injury and a cosmetically undesirable scar.[4] The disadvantages of incision and drainage can be overcome by USG guided drainage of fascial space infections as recently it has been illustrated that USG is not only of diagnostic value in the management of abscesses in the facial region but that it can also be used therapeutically.[5]

This case series intends to illustrate the efficacy of the USG guided drainage of fascial space infections as an effective alternative to traditional method of incision and drainage.

CASE REPORTS

Case 1

A female patient of age 32 years reported to the OPD with pain and swelling on the left lower part of the face and left side of the neck for the past 1 week [Figure 1a]. A diffuse swelling was noted on the left lower 1/3rd of face extending from 1 cm behind the ear lobe to 2 cm posterior to the angle of the mouth postero-anteriorly and 2 cm anterior to the tragus to the upper part of the neck superio-inferiorly measuring approximately 6 × 6 cm. The skin overlying the swelling was stretched and shiny. Swelling was soft and fluctuant with local rise in temperature and tender on palpation. Lymph nodes were not assessed due to the size of the swelling. Intraoral examination was not performed due to restricted mouth opening of less than 10 mm. OPG was carried out and it revealed radiolucency in the periapical region of 37,38. Patient was diagnosed with left buccal, submandibular, submasseteric space infection secondary to a periapical abscess w.r.t 37,38. A diagnostic USG was performed, a well-defined homogenous anechoic impression was noted confirming the diagnosis of left buccal, submandibular and submasseteric abscess [Figure 1b and c]. The pre-operative abscess volume was 5 ml determined using USG. The USG guided drainage was performed by a

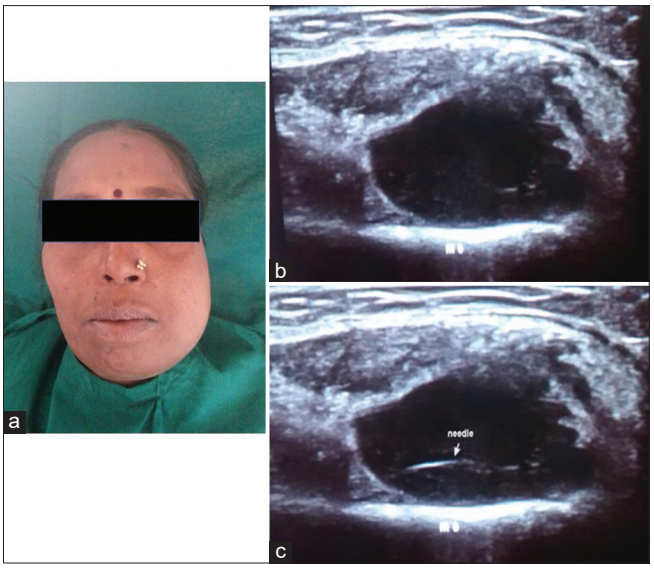

Figure 1: (a) Front profile view showing swelling on the left side (b) USG image depicting homogenous anechoic impression of Left Buccal space abscess (c) USG image depicting needle inserted within the Left Buccal space abscess

postgraduate from the department of Oral and Maxillofacial surgery and an interventional Radiologist guided the procedure using an USG.

Procedure: Skin preparation was done with povidone iodine and spirit. A 16-gauge needle was mounted on a 10 ml syringe and inserted into the abscess cavity, the patient was asked not to move, breathe deeply or swallow during needle insertion to avoid shifting of image. 3.5 ml of pus was aspirated and was sent for culture and sensitivity test. Post procedure residual abscess volume was 1.5 ml. Post operative antibiotics and analgesics were administered. Post 24 hours from the procedure the patient's swelling reduced to 2 × 2 cm and mouth opening increased to 20 mm.

Case 2

A 30-year-old male patient reported to the OPD with pain and swelling for the past 3 days on the right side of the face. Pain was continuous, radiating to the forehead and was of sudden onset. It aggravated on mastication and during late hours in the night. Swelling caused difficulty in mouth opening. A diffuse swelling was noted on the right middle and lower third of the face extending from 1 cm below the infraorbital margin to lower border of the mandible superior-inferiorly on the right side, to 1 cm lateral to the ala of the nose, to 1 cm medial to the tragus of the ear on the right side measuring 4 × 4 cm [Figure 2a]. The skin over the swelling was indurated and was firm in consistency with local rise in temperature. A solitary submandibular lymph node was enlarged on the right side. Mouth opening was 20 mm. Intraoral examination exhibited tenderness on percussion w.r.t 46,47,48. OPG revealed radiolucency involving the

Figure 2: (a) Front profile view showing swelling on the right side (b) USD guided needle insertion for pus drainage (c) USG image depicting homogenous anechoic impression of Right Buccal space abscess (d) USG image showing needle inserted within the Buccal space abscess

enamel, dentine, and pulp w.r.t 47,48. Patient was diagnosed with right buccal space infection secondary to deep dental caries associated with 47,48. A diagnostic USG showed a well-defined homogenous anechoic impression confirming Right Buccal space abscess [Figure 2b-d]. The pre-operative abscess volume was 6.7 ml determined using USG. Standard aseptic protocols were followed. USG guided drainage was performed. 4.5 ml of pus was aspirated and was sent for culture and sensitivity test. The residual abscess volume was 2.2 ml. Post operative antibiotics and analgesics were administered. Patient's infection resolved as the swelling reduced to 2 x 1.5 cm, mouth opening increased to 30 mm after 24 hrs.

Case 3

A male patient of age 55 years reported to the OPD with pain and swelling on the right side of the face for the past 3 days. Pain was of continuous and throbbing type. Pain and swelling was associated with difficulty in mouth opening and intake of food. Facial asymmetry was noted on the middle and lower third of the face on the right side extending from the right infra orbital region to the lower border of the mandible superior-inferiorly and from the right ala of the nose to post auricular region antero-posteriorly measuring approximately 5 × 5 cm [Figure 3a]. Skin over the swelling was shiny, smooth, and stretched. Obliteration of nasolabial fold on the right side was seen. Swelling was firm and tenderness was noted on palpation. A solitary submandibular lymph node was enlarged on the right side. Mouth opening of 20 mm was noted. On intraoral examination, root stumps were present w.r.t 11,13,23,24,33,36,37,44,45. OPG revealed radiolucency involving the periapical region of 11,13,44,45. Patient was diagnosed with right canine and buccal space infection secondary to infected root stumps w.r.t 11,13,44,45. A diagnostic USG showed a well-defined homogenous anechoic impression confirming the right canine and buccal space abscess [Figure 3b-d]. The pre-operative abscess volume was 4.5 ml determined using USG. Standard aseptic protocols were followed. USG guided drainage was performed. 2.5 ml of pus was aspirated and was sent for culture and sensitivity test. The residual abscess volume was 2 ml. Post operative antibiotics and analgesics were administered. Patient's infection regressed as the swelling reduced to 2 × 2 cm, mouth opening increased to 30 mm after 24 hrs.

Case 4

A female patient of age 31 years reported to the OPD with pain and swelling on the left side of the face for the past 1 week. Pain was sudden in onset, sharp and shooting type, radiating to the forehead, and aggravated on mastication and while mouth opening. Diffused swelling was noted on the left middle third of the face extending from the left medial canthus of the eyes to left corner of the mouth superior-inferiorly and from the corner of the mouth to 3 cm medial to the preauricular region medio-laterally measuring approximately 3 × 3 cm. Skin over the swelling appeared normal. On palpation there was a local rise in temperature and tenderness. The lymph node was not palpable. Mouth opening of 10 mm was noted. On intraoral examination deep dental caries was present w.r.t 26 and root stumps w.r.t 37. Vestibular tenderness noted w.r.t 26. OPG revealed radiolucency involving the periapical region of 26. Patient was diagnosed with left canine and submasseteric space infection secondary to periapical abscess w.r.t 26. A diagnostic USG showed a well-defined homogenous anechoic impression confirming the left canine and submasseteric space abscess. The pre-operative abscess volume was 4 ml determined using USG. Standard aseptic protocols were followed. USG guided drainage was performed. Three ml of pus was aspirated and was sent for culture and sensitivity test. The residual abscess volume was 1 ml. Post operative antibiotics and analgesics were administered. Infection was considered resolving as the swelling reduced to 1 × 0.5 cm, mouth opening increased to 20 mm after 24 hrs.

Case 5

A 60-year-old female patient reported to the OPD with pain and swelling for the past 3 days on the left lower part of the face. Pain was of sudden onset, severe, continuous, radiating to the forehead. It aggravated on mastication. Swelling caused difficulty in mouth opening. A diffuse swelling was noted on the left middle and lower third of the face measuring approximately 4 × 4 cm extending from the left angle of the mandible, crosses the midline up to the right corner of the mouth postero-anteriorly and 2 cm anterior to the left tragus to 1 cm below the lower border of the mandible crossing midline superior-inferiorly. The swelling was firm in consistency over the submental region and soft in consistency over the left submandibular region with local rise in temperature and tender on palpation. Bilateral submandibular lymph nodes and submental lymph nodes were enlarged. Mouth opening was 15 mm. Intraoral examination exhibited tenderness on percussion w.r.t 34,35,36,37. OPG revealed radiolucency on the periapical region w.r.t 34,35,36,37. Patient was diagnosed with left submandibular and submental space infection secondary to chronic periapical abscess w.r.t 34,35,36,37. A diagnostic USG showed an ill-defined homogenous anechoic left submandibular and submental space abscess. The pre-operative abscess volume was 7 ml determined using USG. Standard aseptic protocols were followed. USG guided drainage was performed. 5 ml of pus was aspirated and was sent for culture and sensitivity test. The residual abscess volume was 1.5 ml. Post operative antibiotics and analgesics were administered. Infection regressed after 24 hours as the swelling reduced to 2 × 1 cm, mouth opening increased to 20 mm.

Case 6

A 50-year-old male patient reported to the OPD with pain and swelling on the right side of the face for the past 1 week. Pain was sharp, continuous, radiating to the forehead. Swelling caused difficulty in mouth opening. A diffuse swelling was noted on the right middle and lower third of the face extending from 2 cm below the infraorbital margin to lower border of the mandible superior-inferiorly on the right side to 1 cm lateral to the ala of the nose to 3 cm medial to the tragus of the ear on the right-side measuring 4 × 4.5 cm [Figure 4a]. The skin over the swelling was shiny, stretched, firm in consistency with local rise in temperature. A solitary submandibular lymph node was enlarged on the right side. Intraoral examination was not carried out due to restricted mouth opening of 10 mm. OPG revealed radiolucency involving the enamel, dentine, and pulp w.r.t 46. Patient was diagnosed with right buccal space infection secondary to chronic periapical abscess associated with 47,48. A diagnostic USG showed a well-defined homogenous anechoic right buccal space abscess [Figure 4b-d]. The pre-operative abscess volume was 7.5 ml determined using USG. Standard aseptic protocols were followed. USG guided drainage was performed; 5.5 ml of pus was aspirated and was sent for culture and sensitivity test. The residual abscess volume was 2 ml. Post operative antibiotics and analgesics were administered. Infection was considered resolving as the swelling reduced to 1.5 × 2 cm, mouth opening increased to 15 mm after 24 hrs. Summary of investigations of cases [Table 1].

DISCUSSION

The deep neck infections according to Mosher's statement in 1929 still holds true, i.e., "Pus in the neck, calls for the surgeon's best judgement, his best skill and often, for all his courage."[6] Fascial spaces are between fasciae and organs or tissues that are divided into primary and secondary spaces based on direct and indirect involvement from the

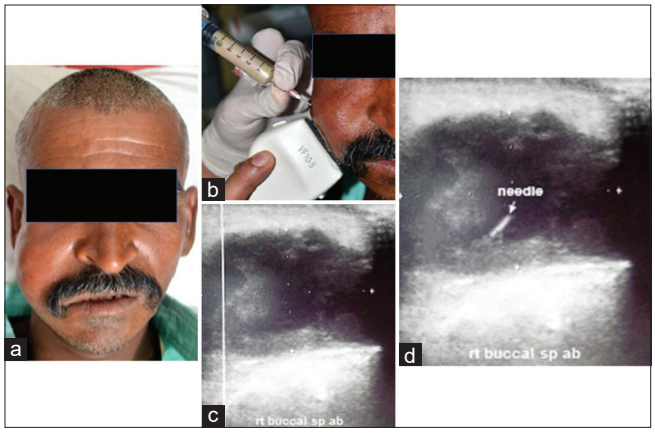

Figure 3: (a) Front profile view showing swelling on the right side of the face (b) USG guided needle insertion for drainage of abscess (c) USG image depicting homogenous anechoic impression on right buccal space abscess (d) USG image showing needle inserted into right buccal space abscess

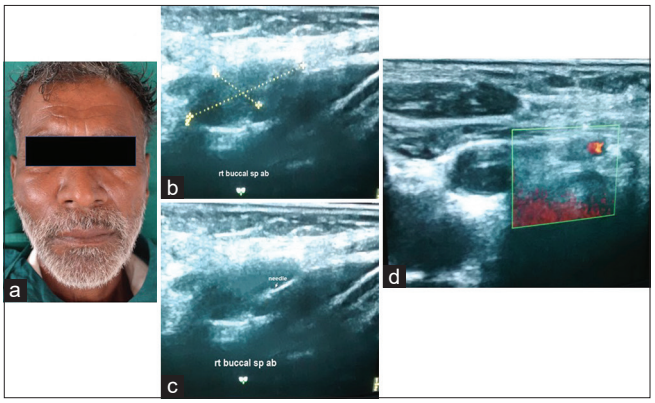

Figure 4: (a) Front profile view showing swelling on the right side of the face (b) USG image depicting homogenous anechoic impression of Right Buccal space abscess (c) USG image depicting homogenous anechoic impression of Right Buccal space abscess with needle (d) Color Doppler image depicting the vascularity adjacent to the abscess

Table 1: Summary of investigations of cases

Cases	Preoperative size (cm)	Post-operative size (cm)	Pre-operative Volume (ml)	Aspirated volume (ml)	Post-operative Volume (ml)	Pre-operative mouth opening (mm)	Post-operative mouth opening (mm)	Bacterial Isolates
Case 1	6×6	2×2	5	3.5	1.5	10	20	Streptococcus Viridans
Case 2	4×4	2×1.5	6.7	4.5	2.2	20	30	Staphylococcus Aureus
Case 3	5×5	2×2	4.5	2.5	2	20	30	Streptococcus Viridans
Case 4	3×3	1×0.5	4	3	1	10	20	Corynebacterium Species
Case 5	4×4	2×1	7	5	2	15	20	Streptococcus Viridans
Case 6	4×4.5	1.5×2	7.5	5.5	2	10	15	Streptococcus Viridans

original focus. Primary spaces include canine, infratemporal, buccal, submental, submandibular, and sublingual spaces. Secondary or deeper spaces include temporal, masseteric, pterygo-mandibular, lateral pharyngeal, retropharyngeal, and prevertebral spaces.[7-9]

In the early stages of a head and neck infection, cellulitis forms the principal clinical picture. Chau *et al.*[10] categorized the range of infection from cellulitis to abscess cavity into four categories

(1) Subcutaneous thickening without disarray or pus accumulation.
(2) Disarray of subcutaneous tissues without pus accumulation.
(3) Disarray of subcutaneous tissues with pus accumulation.
(4) Abscess formation but ultrasonographic findings were not discussed.

The dilemma often, is to differentiate an abscess from cellulitis and to determine whether incision and drainage is necessary. Cellulitis can be treated only with antibiotics. Abscesses in the head and neck region are treated by surgical incision and drainage, along with antibiotics and removal of the causative factor.

The surgical incision and drainage of an abscess with conventional investigations causes pain, tissue trauma, difficulty in assessing the size, boundaries, vital structures, delayed healing. The placement of drains post incision increases the chances of secondary infections and causes inadvertent scarring of tissues on healing. The drains also tend to occlude with the adjacent tissues which causes difficulty in drainage. Patients are often immuno-compromised and thus their post-operative healing is also compromised. Consequently, the hospital stay tends to be prolonged and the medical cost is usually enormous. To avoid all such complications, ultrasonography is an invaluable diagnostic tool. USG aids in localizing even small pockets of pus in the facial region. Its ability to pinpoint the accurate dimensions, precise depth below the skin surface and its relationship with other structures is of paramount importance.[5]

High frequency ultrasound has properties of light such as reflection, refraction, focusing and scattering. The principal advantage of high frequency ultrasound waves is it can be aimed in detecting specific organs and tissues. USG uses these properties to evaluate specific location and accurate extent of any abscess. Images are rapidly acquired and artefacts are few. The technique is highly acceptable in all the patients.[11] The major advantages of USG are portability and real-time imaging, thus leading to intraoperative use. It can also be used to guide needle drainage or aspiration, thus making it a highly specific diagnostic tool.

Ultrasonography is an invaluable diagnostic tool to confirm abscess formation in the fascial spaces and is highly predictable in detecting the stages of infections. USG aids in localizing even small pockets of pus in the facial region. Its ability to pinpoint the accurate dimensions, precise depth below the skin surface and its relationship with other structures is of paramount importance. This eliminates the blind surgical incision and drainage, which may result in excessive tissue trauma, larger than necessary incisions and at times, failure to locate and evacuate the abscess content.[5] As the infection progresses to the stage of abscess and pus formation, anaerobic organisms predominate. This is clinically important for specific narrow spectrum antibiotic therapy and to surgically drain the abscess.[12]

Ultrasonography echogenicities are classified as hyperechoic (brighter), isoechoic (equal), hypoechoic (darker), anechoic (no internal echoes) and mixed. In edematous conditions, the echogenicities of the tissues are isoechoic, like the normal or uninfected side but with increase in the fluid contents. In cellulitis, the echogenicities of the

tissues are higher (hyperechoic) than normal because of massive inflammatory infiltration to the infected region. In the pre abscess condition the echogenicity of the tissues are mixed (hypo echoic and hyper echoic) at the end of cellulitis stage and the beginning of abscess formation stage. In the Abscess stage, the echogenicity of the tissues was absent (anechoic) because of the abscess cavity, which can be solitary or multiple well-defined foci of pus.[4]

Color doppler depicts the anatomic view of vessels. It reveals the mean velocity and direction of blood flow in the region of fascial abscesses. USG with Doppler flow aids in easy identification of fluid filled cavities and at the same time differentiates an abscess cavity from high and low flow blood vessels.[4,10] In our case series we have used color doppler before USG guided drainage to identify vasculature.

Deep fascial spaces like parapharyngeal, retropharyngeal, masticator and sublingual spaces are difficult to access using USG possibly because of the reason that the mandibular body and ramus prevented the transmission of ultrasound signals.[4,13] Intraoral ultrasonography is a simple and safe procedure to identify infections of deeper spaces namely peritonsillar abscess.[5]

In our case series, we have used a 5–7 MHz linear probe for the diagnosis and 16-gauge needle for guided drainage of fascial space infection. A low vacuum suction can be connected to the needle in case of large abscesses to drain effectively. In our study, we have not connected a suction as we were able to successfully evacuate the abscess contents by using the above-mentioned needle insertion technique.

Yusa *et al*.[2] in their study performed US-guided needle aspiration technique, where the needle was inserted parallel to the plane of scanning, using aspiration adapters. This procedure has the advantage of enabling visualization of the whole needle on the display screen. Our technique is also similar to the above method, where the needle is parallel to the plane of scanning and is perpendicular to the midline of the probe. Although it is difficult to visualize the whole needle by this method, the location of the tip or part of the needle relative to the abscess is always visible on the USG display.

Inter-Incisal Opening [IIO] was evaluated in two different time intervals i.e., pre-operatively, post operatively after the treatment. In our case series we found a significant difference in between both the time intervals. In a study conducted by Al-Belasy[3] where they used USGD in submasseteric space abscess a mean IIO of 1.5 cm was observed after drainage of 5 ml of pus.

We evaluated the residual abscess volume post operatively by USG. The residual volume was minimal, and the infection resolved completely in three to five days. This gives us an insight about the utility of ultrasonography in follow up evaluation.

In most of the head and neck infections, streptococci and staphylococci are the most predominant microorganisms followed by anaerobes. Occasionally coliforms are seen.[7,10,14] The microorganisms isolated by performing culture and sensitivity tests in our study case series were streptococcus viridans, staphylococcus aureus, Corynebacterium species, pseudomonas aeruginosa. Attempts to obtain materials for culture are important, but treatment should not await sensitivity reports.[15,16]

Precisely identifying the pathogens and subsequently administering the appropriate antibiotics according to the drug sensitivity tests is the keystone for infection control.[9] Prior antibiotic therapy, sometimes affects culture and sensitivity test (CST) and renders the exudate to be sterile.[16] In our case series, we collected samples for CST prior to subjecting patients to antibiotic therapy. Patients sometimes came to our hospital for treatment with prior antibiotic coverage (mainly Amoxicillin) which revealed a cultural flora mainly consisting of anaerobes.

Penicillins or cephalosporins are the drugs of choice in combination with Metronidazole. The antibiotic regime may have to be modified after the culture and sensitivity report is available.[7,14,17] In our case series, medical management mainly consisted of a penicillin derivative (Amoxicillin + clavulanic acid 625 mg) in combination with metronidazole 400 mg or clindamycin 150/300 mg. All our patients showed sensitivity to these drugs and infections resolved uneventfully. Length of Hospital Stay was based on the resolution of infection which was based on 3 parameters—Inter Incisal Width Increases, residual volume of the abscess and reduction in swelling.[1] The maximum length of hospital stay was 4–5 days.

The B-scan sonography is an invaluable tool in the diagnosis and drainage of abscesses in the facial region as it is an inexpensive, minimally invasive technique, highly sensitivity and specific, characteristics of abscesses including the size, shape, width, marginal demarcations, and locations can be determined, thereby aid in its guided drainage. We recommend that fascial space infections can be accurately detected with a 5–7 MHz linear array probe, preferably with IOU by an Interventional radiologist. Color doppler can be combined to determine the vasculature and blood flow which aids a safe drainage of fascial abscesses for the oral and maxillofacial surgeon. Guided drainage can be performed with a 16-gauge needle, placed perpendicular to the scanning plane, and

connected to low vacuum suction. Followed by antibiotic therapy causes complete resolution of fascial space infections.

CONCLUSION

Ultrasonography is a non-invasive, radiation-less, cost effective, readily available, and repeatable imaging modality. Based on our case series, we conclude USG aids the maxillofacial surgeon towards ultrasonography-guided drainage of fascial space infections effectively, efficiently, accurately, precisely, and effortlessly. Potential and fatal complications such as carotid artery rupture and severe bleeding are avoided. An intraoral approach can be adopted in future, to assess the deeper fascial space infections, such as peritonsillar, parapharyngeal and sublingual spaces. USG has been proved to be an effective adjuvant to the conventional incision and drainage in the management of infections involving the fascial spaces.

Declaration of patient consent

The authors declare that they have obtained consent from patients. Patients have given their consent for their images and other clinical information to be reported in the journal. Patients understand that their names will not be published and due efforts will be made to conceal their identity but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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