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Comparative Evaluation of Ultrasonography and MRI in Detection of Odontogenic Fascial Space Infections: A Prospective Study

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ABSTRACT

Aims and objectives: *Odontogenic infections, if not properly controlled, can spread to adjacent head and neck fascial spaces. However, because of the complicated anatomic structure of the head and neck, fascial space infections are often difficult to be determined by clinical examinations. The aim of the present study was to investigate ultrasonographic characteristics of fascial space infections and to correlate ultrasonography (USG) findings with those of magnetic resonance imaging (MRI). To assess the role of USG and MRI in diagnosing superficial and deep fascial space infections.* ***Materials and methods:*** *Total of 15 subjects clinically diagnosed with space infections secondary to the odontogenic cause were included in this potential study. The fascial space involvements were examined with USG and MRI.* ***Results:*** *A total of 31 fascial space infections were clinically identified in the subjects, comprising 24 superficial (77.41%) and 7 deep spaces (22.58%), whereas, ultrasonography successfully identified 30 involved fascial spaces, with 28 superficial (93.33%) and 2 deep spaces (6.66%). USG, staging for odontogenic fascial space infections revealed 2 edematous changes, 15 cellulitis, and 13 abscesses.* ***Conclusion:*** *Ultrasonography could be reflected to be an inexpensive, non-invasive technique in detecting the spread of odontogenic infections to the superficial fascial spaces.*

Keywords: Fascial space infections, Head and neck, Ultrasonography, MRI

INTRODUCTION

Odontogenic infection comprises a high percentage of maxillofacial infections [1]. These infections, if not properly controlled, can spread to adjacent head and neck fascial spaces and may lead to potentially catastrophic consequences. Involvement of pharyngeal spaces secondary to abscess or cellulitis involving floor of mouth may cause airway obstruction which can be potentially life-threatening complications to patient and need immediate surgical intervention [2]. Fascial space infections cause morbidity and the use of advanced imaging in the detection of spread of infection is helpful for the clinician for better management of the patient [3].

Imaging plays an important role in the management of head and neck diseases. Imaging modalities will not only show the exact location and extent of a lesion but also help to anticipate its nature with visualization of spaces of the neck which are unapproachable by clinical examination. Both CT and MRI are expensive, time-consuming modalities; hence we require adjunctive aid to identify space infections and to provide appropriate management.

Ultrasonography (USG) has played a major role as a diagnostic tool in various medical conditions. In dentistry, only a few studies have been reported with the use of ultrasonography and magnetic resonance imaging in the detection of fascial space spread of odontogenic infection [4,5]. Hence a need was felt to conduct a study to determine the use of ultrasonography as a diagnostic tool in fascial spread of odontogenic infections and its comparison with magnetic resonance imaging as a diagnostic tool in fascial spread of odontogenic infections.

The objective was to evaluate the use of ultrasonography as an alternative imaging modality to MRI in detecting fascial space spread of odontogenic infections.

MATERIALS AND METHODS

The present study was conducted in the Department of Oral Medicine and Radiology; for a duration of one year. In this prospective study, the protocol was reviewed by the appropriate Institutional Review Board. The study subjects were taken from the outpatients attending the Department of Oral Medicine and Radiology. The study group comprised of 15 subjects comprising of 11 males and 4 females with the age ranging from 10 years to 55 years.

Inclusion Criteria

Patients with cellulitis secondary to odontogenic infections, patients with pacemakers were not included in the study.

Exclusion Criteria

The patients with trauma and malignancy causing swelling were excluded from this study.

All subjects were clinically diagnosed with fascial space infections of odontogenic origin and had signed detailed informed consent forms before being examined with USG and MRI. The imaging was performed before any surgical procedures. Two radiologists interpreted each image. The diagnosis was confirmed by response to clinical management. The imaging characteristics were recorded in all patients and their management and final diagnosis documented on a prescribed proforma. The results were analyzed, studied and compared with similar studies in the past.

Radiological Evaluation

Ultrasonography: All the clinically positive patients were subjected to examination by high-resolution ultrasonography on Toshiba Aplio XG USG Unit (Japan) with 7.5 MHz linear array transducer probe. The probe was applied over the skin covering the suspected area in transverse and axial directions to determine the presence or absence of fluid collection and its anatomic location. Bilateral images from both infected and non-infected sides were obtained for comparison. All grayscale ultrasound images were analyzed, and focal lesions were measured using onscreen calipers. Ultrasound echogenicities were described in comparison with adjacent tissues as follows: hyperechoic (brighter), isoechoic (equal), hypoechoic (darker), anechoic (no internal echoes), or mixed.

Spreading infections were determined by comparing shape and signal intensities of the fascial spaces of the non-infected sides. Cellulitis was considered to be present when soft tissue swelling or infiltration was seen, usually accompanied by obliteration of adjacent fat planes with high or low signal intensity but with no evidence of localized fluid collections.

Magnetic resonance imaging: All subjects were scanned on a GE HDe Signa 1.5-T unit with a dedicated coil technique which included 3-5 mm axial and coronal T1 weighted images, with enhancement and fat suppression in at least one plane, and axial T2 weighted fat-suppression FSE 4-5 mm images, all from the skull base to the clavicles.

The imaging protocol included the axial and coronal planes. T1-weighted (TR/TE: 500/15 ms to 20 ms) and T2-weighted (TR/TE: 5,000/110 ms) non-contrast spin echoes and short tau inversion recovery (TR/TE/TI: 2,500-3,800/22/90 ms to 110 ms) sequences were used.

Sections of 4 mm to 5 mm with a small interslice gap, and small field-of-view imaging (i.e., 12 cm to 14 cm in the neck) provided adequate images of the neck, while in the mediastinum, the field-of-view may be increased. Image analyses were conducted on ADW 4.4 work station and a conclusive diagnosis was made.

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Statistical Analysis

All the values were categorized according to different spaces for the 3 investigations clinically, by USG and MRI for superficial and deep spaces respectively. The data thus was subjected to statistical analysis using SPSS version 16. The statistical methods used were descriptive statistics and Chi-square test.

RESULTS

In the present study, 15 patients clinically diagnosed with fascial space infections of odontogenic origin were enrolled. The age group of the subjects ranged from 10-55 years comprising of 11 males and 4 females, with the mean age being 33.62 years. After analyzing the data of all the 15 patients we noted that swelling was the most common complaint (15 patients) (100%) followed by pain (14 patients) (93.33%) trismus (10 patients), (66.66%) and dysphagia (6 patients) (40%).

On the basis of previous study 15 fascial spaces were divided into superficial and deep spaces. Superficial spaces included buccal, canine, infraorbital, submandibular, submental, masseteric spaces. Deep spaces included sublingual, parapharyngeal, retropharyngeal, pterygomandibular, temporal, pharyngeal mucosal, and carotid spaces.

A total of 31 fascial spaces infections were identified clinically in the subjects. These 31 fascial spaces were further divided into 24 (77.41%) superficial and 7 (22.58%) deep spaces. Submandibular space was the most commonly involved superficial space (10 spaces) (41.66%) followed by buccal (4 spaces) (16.66%) masseteric (4 spaces) (16.66%), infraorbital (3 spaces) (12.5%) canine (2 spaces) (8.33%) submental (1 space) (4.1%).

Ultrasonography successfully identified 30 involved fascial spaces. Of the 30 spaces, USG identified 28 superficial (93.33%) and 2 deep spaces (6.66%). Of the 28 superficial spaces, USG identified 11 submandibular space (39.28%). The second most commonly involved fascial space was buccal space (6 spaces) (21.42%) followed by the masseteric (5 spaces) (17.85%), infraorbital (3 spaces) (10.71%) canine (2 spaces) (7.14%), submental (1 space) (3.57%) (Figure 1). Apart from that in one patient incidental finding of cysticercosis was observed in the right temporalis muscle.

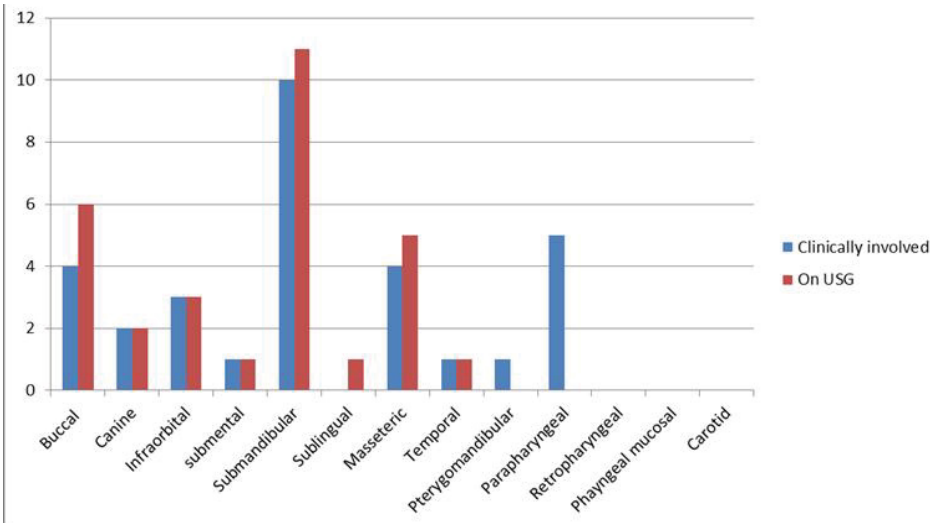

Figure 1 Fascial spaces involved clinical v/s USG

On the other hand, MRI substantially identified 52 fascial spaces in 15 patients. Of the 52 spaces, MRI identified 29 superficial (55.76%) and 23 deep spaces (44.23%). Of the 29 superficial spaces, MRI identified 11 submandibular spaces (37.93%). The second most commonly involved fascial space were the masseteric space (6 spaces) (20.68%), buccal space (6 spaces) (20.68%) They were followed by the infraorbital space (3 space,) (10.34%), canine space (2 space,) (6.89%) submental space (1 space) (3.44%). The sublingual space (6 spaces) (26.08%) was the most commonly involved deep space, followed by the parapharyngeal space (4 spaces) (17.39%) the pterygomandibular space (4 spaces) (17.39%) retropharyngeal space (3 space) (13.04%) pharyngeal mucosal space (3 space) (13.04%) temporal space (2 space) (8.69%) carotid space (1 space) (4.34%).

On clinical evaluation, we were able to detect 31spaces (59.61%), while ultrasonography detected 30 fascial spaces (57.69%) versus MRI's 52 fascial spaces (100%). Both USG and MRI showed similar results in the identification of superficial fascial space infections, including the buccal, canine, infraorbital, submandibular, submental spaces.

No significant difference was observed in different pairs of investigations-between USG and MRI ($p=0.93827$), USG and clinical ($p=0.74100$) and MRI and clinical ($p=0.6819$) by unpaired t-test in superficial spaces at 5% level of significance.

One way ANOVA F-test revealed no significant difference (p=0.908958506) among 3 techniques for different superficial spaces.

Karl Pearson's correlation coefficient shows a strong (+) ve and significant correlation among the 3 techniques for the superficial spaces that means p>0.05.

MRI demonstrated superiority in identifying the extension of the infection into deeply located fascial spaces, which included the parapharyngeal, retropharyngeal, pharyngeal mucosal space, and sublingual spaces. While the significant difference was observed between USG and MRI (p=0.00200), MRI and clinically (p=0.02879) involved space investigations by unpaired t-test deep spaces i.e p>0.05.

One way ANOVA F-test revealed significant difference was observed (p=0.002656344) between 3 techniques for different deep spaces i.e p>0.05.

USG was useful in identifying the stages of infection: edematous changes (increase in fluid contents), cellulitis (hyperechoic inflammatory infiltration) and complete abscess formation (anechoic) (Figures 2 and 3).

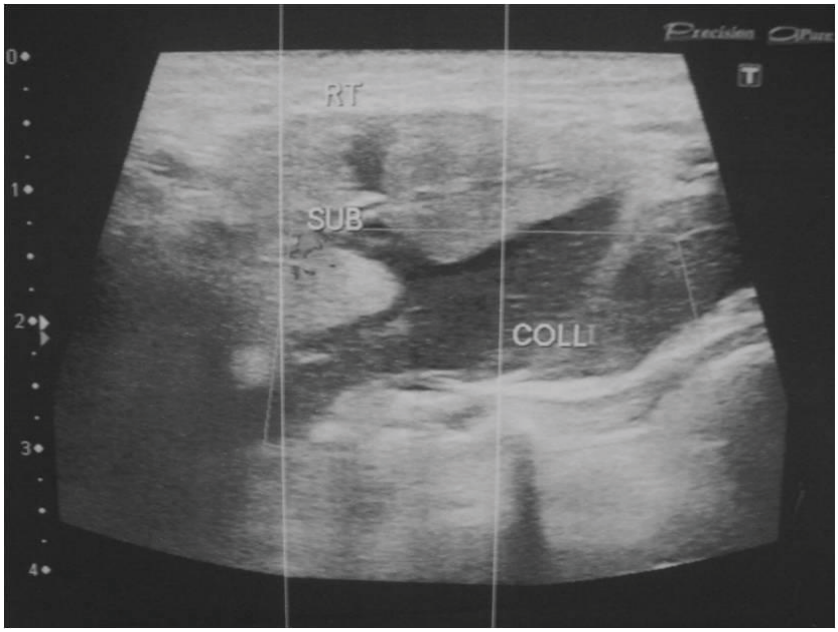

Figure 2 USG showing hyperechoic ill-defined inflammatory collection

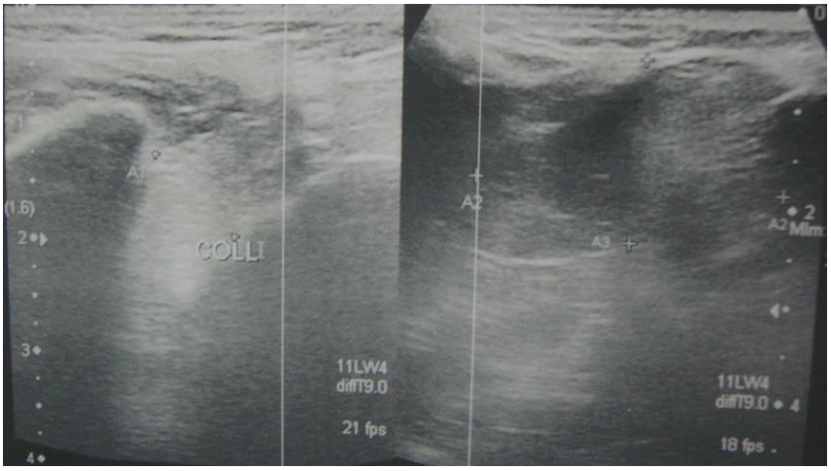

Figure 3 USG showing fluid collection

According to the findings of USG, there were 2 edematous changes, 14 cellulitis alone, and 12 abscesses in superficial

spaces while in deep spaces USG was able to detect only 1 cellulitis and 1 abscess (Figure 4). While a weak (+) ve and no significant correlation was observed for 3 techniques for deep spaces. MRI was able to identify 17 cellulitis and 12 abscesses in superficial spaces and 1 edematous change, 10 cellulitis and 12 abscesses in deep spaces.

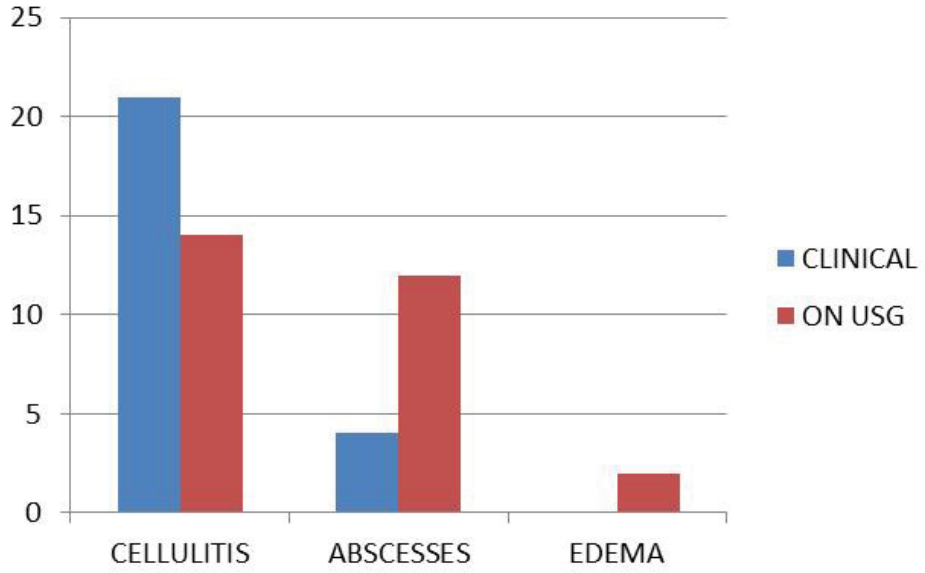

Figure 4 Grade of infection clinical v/s USG for superficial spaces

Incision and drainage were performed in 8 subjects. Patients with cellulitis and edema without significant complications received antibiotics and comprehensive supportive therapy. Clinical examination was able to identify 20 cellulitis and 4 abscesses in superficial spaces while 7 cellulitis in deep spaces.

DISCUSSION

Fascial spaces are fascia lined areas that can be eroded or distended by purulent exudates. These areas are potential spaces that do not exist in healthy people but become filled during infections [2]. Early detection and identification of involved space is the key to successful management of space infection.

In the present study, the swelling was observed to be the most common complaint (15 patients, 100%) followed by pain (14 patients, 93.33%), trismus (10 patients, 66.66%) and dysphagia (6 patients, 40%). These findings were similar to those observed by Bassiony, et al., which suggests poor awareness of the patients towards their oral health or the increased tendency of infections due to their immune-compromised status secondary to the presence of other systemic diseases [4].

In our study, we compared the clinical judgment of fascial space involvement with USG findings. To our knowledge, no study has compared the 2. This becomes important to establish the additional diagnostic value of an ultrasonographic examination. In a total, 31 fascial space infections were clinically identified in the subjects, comprising 24 superficial (77.41%) and 7 deep spaces (22.58%) whereas ultrasonography successfully identified 30 involved fascial spaces, with 28 superficial (93.33%) and 2 deep spaces (6.66%).

We analyzed that USG has a significant role in the staging of infection. USG is proficient to stage the infection into cellulitis, abscess, and edema in superficial spaces [6-8]. On comparing the result of clinical working diagnosis with USG in the staging of infection in superficial spaces, our results were found to be statistically significant with a p=0.0266. Our results were in accordance with the study done by Mukhi, et al., and Aarthi, et al., [9,10].

USG can eliminate the need of contrast medium administration for determination of abscess by CT and MRI in superficial spaces as shown by our study [4,5]. USG can be used as an aid to imaging modality in patients allergic to contrast medium. USG can be very useful if repeated examinations are needed for hospitalized patients as there is no associated risk to the patients because USG has no radiation exposure to the patients [11]. By our findings, we can suggest that USG is somewhat similar to clinical assessment but it is better at the staging of infection. MRI identified a total of 23 deep spaces. This suggests that imaging modalities can refine our diagnostic significance.

Both USG and MRI showed similar results in the identification of superficial fascial space infections and these results were in accordance with previous results reported in the literature [4]. These results signify that USG can be used as a substitute for MRI for screening superficial space infections.

MRI proved to be significantly fruitful in identifying the extension of infection into deep fascial spaces, including parapharyngeal, retropharyngeal, pharyngeal mucosal space, and sublingual spaces. These results compare well with the observations of Bassinoy, et al., [4].

Poor identification of deeper spaces using USG could be because of the presence of mandibular body and ramus, which might have prevented the transmission of ultrasound signals thereby obliterating the image. USG can be performed to confidently screen, temporal space, and submasseteric spaces and can be considered as a modality of choice for the patients who cannot bear the higher cost of an MRI.

CONCLUSION

Ultrasonography is a quick, widely available relatively inexpensive, painless and can be repeated as often as necessary without risk to the patient. Ultrasonography could be considered as an alternative imaging modality to MRI in detecting the spread and staging of odontogenic infections of the superficial facial spaces.

Following are the conclusions drawn from our study:

On the other hand, the gold standard technique, MRI, identified a total of 52 fascial spaces comprising of 29 superficial and 23 deep spaces. So, clinical, ultrasound and MRI had the same capabilities in the detection of all the superficial fascial spaces whereas ultrasound has a very minimal role in the detection of deep fascial spaces as compared to MRI.

- A careful examination and assessment can be equally predictive of correct diagnosis of the involved spaces. Ultrasound does not significantly add to the clinical management
- Ultrasound is not helpful in detecting deep fascial space involvements
- Further, the findings of ultrasonography were highly predictable in detecting the stage of infection from edematous change to abscess formation

DECLARATIONS

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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