Original Article

Procalcitonin – A Novel Biomarker for Diagnosis and Evaluation of Treatment Response in Maxillofacial Infections – A Pilot Study

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Abstract

Background: Odontogenic maxillofacial space infections are potentially fatal infections that needs urgent medical and surgical care. Most of the odontogenic infections are bacterial and early and prompt diagnosis of bacterial infections is sometimes difficult. Similarly evaluation of treatment response has the effect of minimizing unnecessary antibiotic prescriptions. Conventional markers of infection fail to properly evaluate the treatment response and there lies the significance of procalcitonin (PCT). This has high sensitivity and specificity for identifying bacterial infections and helps in treatment monitoring. **Materials and Methods:** Ten cases of Maxillofacial space infections with involvement of more than two spaces were included in the study. Demographic data and vital signs were recorded. Total white blood cell (WBC) counts and PCT levels were measured at admission, 24 h, 48 h, 96 h, and after 1 week. The values were subjected to statistical analysis. **Results:** PCT value decrease was found to be statistically significant compared to the total count values between 24 h and 48 h time period as well as 48/96 h periods, thus showing the positive response of patients to antibiotic therapy which was seen by clinical improvement as well. **Conclusion:** PCT is a promising biomarker to determine the treatment response in maxillofacial space infections and it helps in deciding the treatment duration with antibiotics as well.

Keywords: Antibiotic resistance, Complete blood count, C-reactive protein, Maxillofacial infections, Procalcitonin, Total count.

Introduction

Odontogenic maxillofacial space infection refers to infections involving potential spaces and facial planes of the maxillofacial region originating from a purely odontogenic or tooth related cause.[1] Over the years, the incidence of space infections has decreased due to improved care available but they are always a challenging problem to the treating maxillofacial surgeon because of the complex anatomy and multiple complications that can occur despite good symptomatic management. Septicemia, airway compromise, necrotizing fasciitis, cavernous sinus thrombosis, and potential mediastinitis can develop subsequent to orofacial infections and are potentially fatal.[2,3]

Diagnosis of bacterial infections is sometimes difficult, because clinical presentation of infections from different causative agents can have features that are identical. This is of significance in cases where in exact foci of infection is not detected.[4]

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Procalcitonin (PCT) is an excellent biomarker to detect bacterial infections with high sensitivity and specificity. PCT is the precursor of the hormone calcitonin and is synthesized by C cells in thyroid. It is also produced by peripheral blood mononuclear cells in response to bacterial infections and mediated by cytokines interleukin-6 (IL-6), tumor necrosis factor-α (TNF-α), and IL-1β.[5,6]

Serum PCT concentration in normal individuals is typically <0.1 ng/mL. In the presence of bacterial infection, PCT increases, and the amount of rise is proportionate with the severity of the infection. It is detectable 3–4 h following

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an infection, immediately following the release of TNF-α at 90 min and IL-6 at 3 h. It peaks at 6–12 h and has a half-life of about 24 h. This make it suitable for diagnosis and disease progression monitoring. Whenever there is a favorable response to treatment, the values of PCT is found to reduce by half in a day thus helping in planning of antibiotic duration.[7,8]

Most of the studies have focused on upper/lower respiratory tract infections and very few studies in the literature have used this potential biomarker for maxillofacial infections. Thus, we conducted this study to evaluate the utility of PCT in determining the duration of antibiotic treatment for odontogenic fascial space infections.

Materials and Methods

Sample population

Ten patients who reported with symptoms of fascial space infection to the department of oral and maxillofacial surgery in a 3-month period were included in this pilot study. After obtaining informed consent from the patients, they were enrolled into the study (Figures 1 and 2).

Inclusion criteria

Patients of age 20–70 years with fascial space infection involving more than one space were included and manifesting as facial swelling with an increase in temperature above 37.5°C were included in the study.

Exclusion criteria

Patients with comorbidities other than diabetes were excluded and infections isolated to single space were also excluded from the study.

Demographic data such as age and sex, vital signs, and glycemic status were evaluated.

Antimicrobial drugs were administered from the day of admission to the day before discharge and the abscess was drained. On admission, complete blood count and PCT were done. At 24 h, 48 h, 96 h, and at 1 week, serial readings of total count and PCT were taken.

The data were subjected to statistical analysis, student t-test was employed to check the efficiency of total count and PCT values in identifying the response to treatment. Comparison was done between 24 h sample and 48 h sample, 48 h sample, and 96 h sample to check which among total count and PCT were good predictors of treatment response.

Results

The study sample of ten patients included six females and four males with an average age of 51 years (range 25–67 years). Six patients were known diabetics under medication and out of that one patient had uncontrolled glycemic levels. The average HbA1c value of diabetic patients was 6.7 and ranged from 5.9 to 7.4.

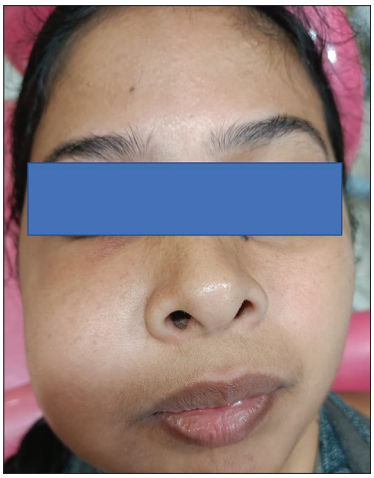

Figure 1: Patient with space infection

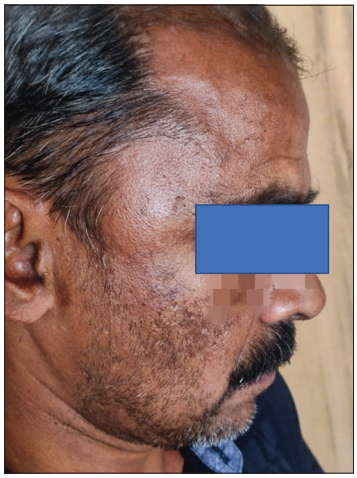

Figure 2: Patient with space infection

All the patients had a rise in temperature the average value being 38.16°C (range 37.3–38.6°C). All patients had tachycardia with mean heart rate of 89.

Average total counts at admission ranged between 13.6 × 10^6/μL to 19.3 × 10^6/μL (Mean value 15.99 × 10^6/μL). At 24 h, the mean was 15.4 × 10^6/μL and at 48 h 14.74 × 10^6/μL.

At 96 h, it was 13.63 × 10^6/μL and by 1 week, it reduced to 11.67 × 10^6/μL still at the upper limit of normal values (Figure 3).

PCT values at admission ranged between 0.7 and 18.9 ng/mL (average 7.11 ng/mL). At 24 h and 48 h, the average values were 3.59 and 1.18 ng/mL, respectively. By end of 96 h post-admission, the average PCT values reduced to well within normal limits of 0.046 ng/mL (range of 0.03–0.07 ng/mL) and at 1 week further reduced to 0.035 ng/mL (Figure 4).

Student's t-test showed statistically significant reduction in PCT values between 24 h and 48 h values and 48 h/96 h values ($P < 0.05$) but the change in values in the total count was insignificant.

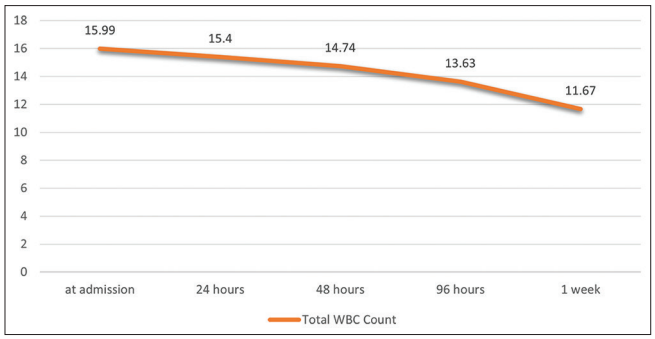

Figure 3: Total white blood cell count

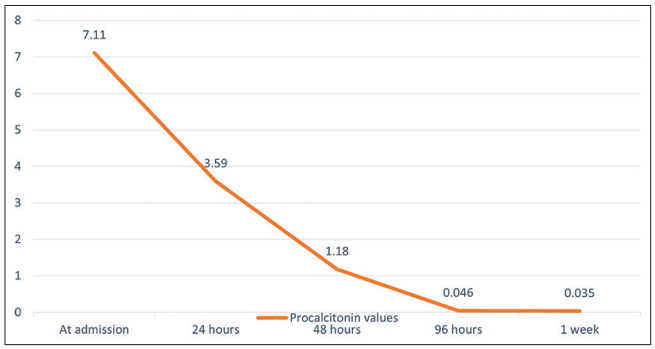

Figure 4: Procalcitonin values

Discussion

Maxilloafacial space infections are high risk infections with potential life-threatening complications but the conventional markers of infection like white blood cell (WBC) count or C-reactive protein (CRP) are of less sensitivity to detect as well as to identify the treatment responses.[9,10]

Proper and accurate diagnosis is of prime importance in ensuring a good treatment outcome especially in doubtful cases of patients showing sepsis, it could be due to a odontogenic deep space infections or due to a viral infection. In such cases, it is of prime importance to find out whether the infection is bacterial or viral, because empirical antibiotics are ineffective as well as of concern causing resistance if the infection was of viral origin. It is also necessary to avoid extensive use of antibiotics and they are to be stopped only if there is a satisfactory reduction in parameters checking for infection. One such exclusive biomarker for bacterial infection is PCT.[4,11,12]

Pro calcitonin matures to calcitonin only in thyroid c cells and PCT produced in other parenchymal cell does not mature into calcitonin due to the absence of CALC-1 gene.[13,14]

Promising results have been obtained for PCT use is in adults with respiratory tract infections and in the critically ill patients, and randomized controlled trials have demonstrated the safety and effectiveness of PCT guided antibiotic therapy.[15]

PCT values have 88% sensitivity and 81% specificity in comparison with routinely used CRP or WBC counts to check for treatment responses.[16] PCT was suggested to have superior efficacy

compared with CRP in predicting bacteremia in patients with community-acquired pneumonia.[17] Decrease of elevated PCT levels correlates adequately and safely with resolution of bacterial infections to allow for the discontinuation of implemented antibiotic therapy, even if this stoppage occurs before the traditional length of a typical course of antibiotics has elapsed.[17,18]

The clinician should also be aware of other reasons for increase in PCT like recent Major surgery, cardiogenic shock, life-threatening fungal/malarial infections but there is decreasing trend in subsequent measurements. Paraneoplastic syndromes and drugs like antilymphocyte globulins, alemtuzumab also raise the levels.[19-21]

Our study investigated whether PCT has better diagnostic utility in patients with odontogenic maxillofacial infections than other routine laboratory tests such as WBC count or Total Count. There was an increase in the PCT value as the number of spaces involved was more. In our series, the maximum value was found in a diabetic patient with involvement of four spaces – buccal, submandibular, submental, and sublingual.

We also utilized the reduction in Procalciton value as an indicator to stop the antibiotic regimen with good clinical outcomes and significant patient improvement. There was a statistically significant reduction in the values when the results of 24 h–48 h and 48–96 h were compared showing the success of treatment. Whereas the change in total counts was not significant.

We were able to reduce the antibiotic regimen at the end of 96 h based on the values of PCT.

Conclusion

PCT promises to be a good biomarker for bacterial infections and can monitor the severity of infections and the treatment response as well. The high sensitivity and specificity over conventional markers like total count and CRP can be utilized in maxillofacial setting as well. Proper monitoring helps to reduce the antibiotic treatment duration thereby helping to overcome dreaded antibiotic resistance.

Limitations and suggestions

Being a pilot study, we included small sample only but the results are promising to warrant a long-term prospective study.

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