Print ISSN: 2321-6379
Online ISSN: 2321-595X

Original Article

Serum C-reactive Protein as a Monitoring Tool for Odontogenic Infections: A Prospective Study

Deval Mehta, Sonal Madan, Tejas H Prajapati, Setu P Shah, Ekta Mistry, Shalin D Shah

Department of Oral and Maxillofacial Surgery, College of Dental Sciences and Research Centre, Ahmedabad, Gujarat, India

Abstract

Background and Objectives: Acute odontogenic infections are a common cause of emergency visits to the maxillofacial outpatient department. C-reactive protein (CRP) is present in small amounts in a normal healthy person and increases up to 1000-fold with in just a few hours of the development of clinical symptoms, and concentrations are raised in almost all inflammatory, infectious, and neoplastic diseases. The study was conducted to assess efficacy of serum CRP levels as a monitoring tool for determining severity of odontogenic infections and efficacy of treatment.

Materials and Methods: A prospective study was conducted on 30 patients diagnosed with facial space infection of odontogenic origin in which 15 were male and 15 were female. Blood samples were collected on days 0, 3, and 7 for measuring serum levels of marker. Simultaneously, clinical parameters such as grades of dysphagia, hoarseness of voice, swelling size, number of spaces involved and pus discharge, and mouth opening were recorded on day 0, 3, and 7 and appropriate treatment given to each patient. Correlation between CRP and clinical parameters was assessed using regression and paired *t*-test.

Results: Statistical analysis found strong correlation between CRP and parameters used to measure severity of infection. Furthermore, CRP is a significant marker for hospital stay ($P < 0.01$).

Conclusion: Prospective analysis indicates that CRP can be effective marker for determining severity of infection, treatment efficacy, and hospital stay. Duration of antibiotic usage, intensive unit care, and use of nutritional supplements become more rationale. Monitoring of CRP also makes treatment cost effective and helps protecting patients from side effects of excess drug usage.

Key words: C-reactive protein, Facial space, Infection, Odontogenic

INTRODUCTION

Patients with fascial space infections of odontogenic origin are at utmost risk for life-threatening situations due to anatomical connectivity of potential spaces to one another. Lethal complications may become inevitable making vigilant scrutiny and monitoring of such patients a necessity. Although conventional measures to estimate infections such as white blood cells (WBC) count and erythrocyte sedimentation rate (ESR) values are valuable in determining state of patient at testing time.[1]

C-reactive protein (CRP) was first described in 1930, when Tillet and Francis reported that serum from individuals acutely ill with lobar pneumonia was able to precipitate a substance derived from the C polysaccharide of *Streptococcus pneumoniae*, which they called fraction C. They noted that when serum was collected from patients when they were acutely ill, there was a strong precipitation reaction but the strength of the reaction decreased as the patients recovered. This observation suggested that this reaction could be used as a marker of disease.[2]

Hence, in the present study, we assessed the efficacy of serum CRP levels as monitoring tools in 30 patients with fascial space infections of odontogenic origin, for determining severity of infections, length of hospital stay, and efficacy of treatment regime.

Access this article online

www.ijss-sn.com

Month of Submission : 06-2021
Month of Peer Review : 07-2021
Month of Acceptance : 07-2021
Month of Publishing : 08-2021

Corresponding Author: Dr. Tejas Prajapati, A-11 Shrusti Tenament, Sec-A, T.p-13, Chhani Jakatnaka, Vadodara- 390 024, Gujarat, India.

MATERIALS AND METHODS

This is a prospective study conducted on 30 patients of with the age group between 21 years and 67 years. Fifteen patients were female and the remaining 15 patients were male patients. Three patients were diabetic and nine patients had history of hypertension. An informed consent was taken from the patient. The patient selected was those with carious or periodontally involved tooth which could be correlated clinically and radiographically as foci of infection. Medically compromised patients, immunocompromised patients, pregnant woman, chronic alcoholics, patients on steroid therapy, and contraceptives were excluded for the study. Non-surgical and surgical treatments were conducted. Non-surgical management included antibiotic therapy, NSAIDs, and vitamins. Surgical management included incision and drainage followed by extraction of the offending tooth.

The following parameters were specially recorded on the day 0 (on the day of diagnosis), 3 and 7 of the visit of each patient during the study.[3]

1. Grades of dysphagia:
   - Grade 1: Normal swallowing
   - Grade 2: Difficulty swallowing some hard solids but can swallow semisolids
   - Grade 3: Unable to swallow any solids but can swallow liquids
   - Grade 4: Difficulty in swallowing liquids
   - Grade 5: Inability to swallow saliva.
2. Clinical evaluation of hoarseness of voice:
   Maximum phonation time was recorded. This is a measurement of the duration a patient can sustain a vowel sound in one breath. Normal values range between 15 and 25 s. Decreased values indicate incomplete glottic closure or insufficient lung support. It was denoted as present or absent.
3. Facial swelling:
   Facial measurements were taken by marking 5 points on the face, that is, symphysis, mastoid, angle of mandible, lateral canthus of eye, and the alae of nose. Anteroposterior measurements were made by a line from point of symphysis to mastoid point. Superoinferior measurements were carried out by two lines, that is, one by joining the point from angle of mandible to lateral canthus of eye and other by joining points from angle of mandible to alae of nose.
   Measurements were made by a black silk suture material and recorded in cm by keeping it over a ruler. An average value of all the three measured lines was taken.
4. Number of spaces involved:
   The number of spaces signifies whether there is involvement of a single or multiple spaces.
5. Discharge of pus/fluid:
   The discharge of the pus or fluid from the sinuses, both intraoral and extraoral were recorded as present or absent.
6. Mouth opening:
   Interincisal opening was measured preoperatively as well as on the subsequent visits. The distance between the interincisal length were measured in centimeters; 0–1.5 cm – severe trismus; 1.6–3.2 cm – moderate trismus; 3.3–4 cm – minimal trismus; and above 4 cm – no trismus present.
7. Measurement of CRP:
   Blood samples were drawn 3 times from each patient for estimating serum levels of CRP on day 0, 3, and 7. Blood samples were collected from the antecubital vein by aseptic technique using 2 ml disposable syringe. At every scheduled visit, 2 ml of blood was withdrawn and used for the estimation of CRP quantitatively, using CRP-Turbilatex.

   CRP-Turbilatex is a quantitative turbidimetric test for the measurement of CRP in human serum or plasma. The basic principle of this test is that the latex particles coated with specific anti-human CRP is agglutinated when mixed with a sample containing CRP.

RESULTS

This was a randomized prospective study conducted on 30 patients with diagnosis of infections of odontogenic origin, with the age group between 21 years and 67 years. Fifteen patients were female and the remaining 15 patients were male patients. Pearson's correlation and paired *t*-test were used to assess the correlation between severity of infection and serum CRP levels.

In this study, level of significance was considered as 0.01 (*P*-value). Of the symptoms, 12 (40%) patients had Grade II and III dysphasia on the reporting day which was absent on following days [Table 1]. Hoarseness of voice was present in 25 (83%) patients and 17 (56%) on the 3rd day and absent in 28 (93%) on the 7th day [Table 2]. The mean change in the number of the spaces involved, swelling size (SS) and CRP value decreased on subsequent days (i.e., from 0 to 3rd day and from 0 to 7th day) with high significance ($P < 0.01$) [Table 3]. The improvement in the mean change in the mouth opening was also seen on subsequent days with high significance ($P < 0.01$) [Table 3]. Preoperatively, one patient had CRP level below 10 mg/L (mild-moderate), 26 patients had CRP levels between 10 and 100 mg/L (moderate-severe), and three patients had CRP levels above 100 mg/L (severe infection). Among them following antibiotic therapy and treatment, CRP

Table 1: Grades of dysphagia

Dysphagia	Day 0	Day 3	Day 7
Grade 1	18 (60.00)	21 (70.00)	30 (100.00)
Grade 2	6 (20.00)	9 (30.00)	0 (0.00)
Grade 3	6 (20.00)	0 (0.00)	0 (0.00)
Total no. of patient	30 (100.00)	30 (100.00)	30 (100.00)

Table 2: Hoarseness of voice

Hoarseness of voice	Day 0	Day 3	Day 7
Present	25 (83.33)	17 (56.66)	2 (6.66)
Absent	5 (16.66)	13 (43.33)	28 (93.33)
Total no. of patient	30 (100.00)	30 (100.00)	30 (100.00)

Table 3: Mean change±SD of SS, CRP, and mouth opening with time

Evaluation	Day 3	Day 7
Mean change±SD of SS	–23.57±4.52	–41.70±0.01
Mean change±SD CRP	–27.80±12.74	–44.34±30.67
Mean change±SD of MO	10.90±0.03	15.43±0.12
P-value (SS, CRP, and MO)	<0.001	<0.001
Significance	HS	HS

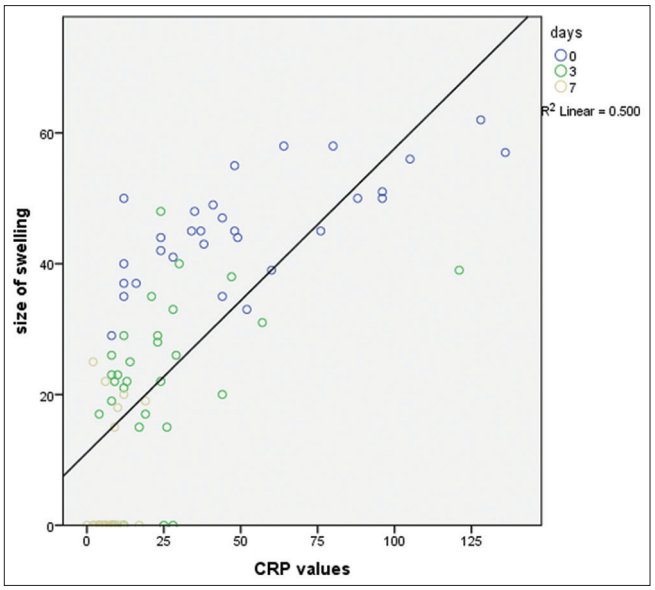
CRP: C-reactive protein, SS: Swelling size, MO: Mouth opening

concentration rapidly returned to a level below 10 mg/dl in 24 patients (80%) who had elevated CRP levels, but remained at the elevated level (≥10 mg/L) in the other 6 patients (20%) on the 7th day (1 week) after treatment.

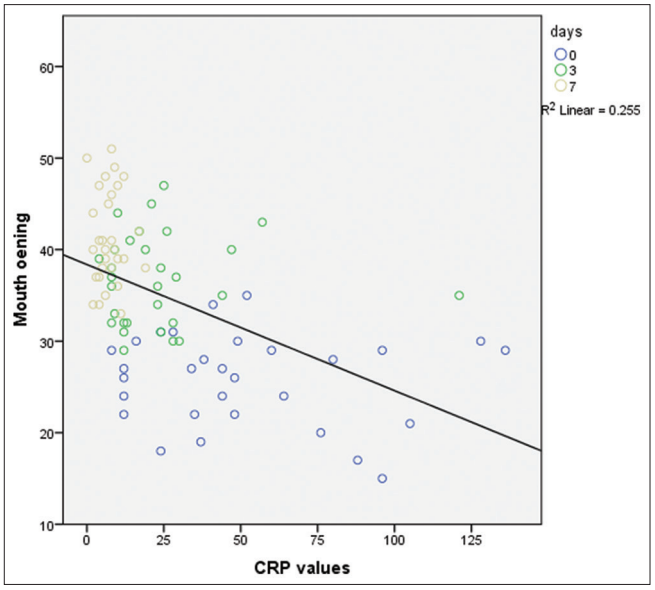
A correlationship was established between the CRP value and the clinical parameters. There was direct and linear relationship between the CRP level and the SS [Graph 1], and an inverse relationship with the mouth opening, as with the degrading CRP level the mouth opening increases [Graph 2].

DISCUSSION

Serum CRP is present only in small amounts in normal healthy individuals (<0.3 mg/L) and increases significantly when tissue damage occurs during infection, tissue injuries, or inflammation. Cytokines produced and released during tissue damage and inflammation, specifically interleukin-6 and TNF-α, induce the production of CRP in hepatocytes.[1,3,4] CRP production is proportional to the severity of tissue damage.[5] Its serum concentration can increase up to 1000-fold or more in response to various acute stimuli associated with infections and other types of tissue injuries.[1] CRP augments the immune response to certain antigens, activates complement, and increases the monocytic production of tissue factors. CRP concentrations are elevated in almost all inflammatory, infectious, and neoplastic diseases.[6]



Graph 1: C-reactive protein versus swelling size



Graph 2: C-reactive protein versus mouth opening

High CRP levels were found to be indicative of odontogenic infections that require intensive care,[7] although acute dental infections, including acute alveolar abscess and acute periodontal abscess, are common causes of outpatient emergency visits in a dental clinic.[8]

Similar to the application of ESR and WBC counts, testing for CRP is most commonly performed to indicate the presence of acute inflammation and to monitor the development of post-operative infections. The rapid rise and fall of CRP with the inflammatory process makes it a much more sensitive indicator of inflammation than ESR and WBC counts.[9-12] The half-life of CRP in the circulation is not significantly influenced by age and gender, and its

serum concentration is largely determined by the rate at which CRP is produced and released into the blood. The close association of serum CRP concentration with the nature and intensity of the activating stimulus has allowed CRP to be used to discriminate bacterial from viral infections, and gauge therapeutic responses for inflammatory diseases.[13]

For dysphagia, out of 30 (100%) patients which were included in study, 18 (60%) patients had Grade 1 dysphagia, 6 (20%) patients had Grade 2, and 6 (20%) patients had Grade 3 dysphagia on the day 0. On day 3, there were 21 (70%) patients with Grade 1 dysphagia, 9 (30%) patients with Grade 2 dysphagia, and 0 patient with Grade 3 dysphagia. Moreover, on the 7th day, all the 30 (100%) patients had Grade 1 dysphagia which is normal swallowing. Study was done by Singh *et al*.[3] in which they found that dysphagia was seen in 76% (Grade II) of patients on day 1 which was totally absent on day 7.

Hoarseness of voice was present in 25 (83.33%) patients and absent in 5 (16.66%) patients on the day 0. On day 3, there were 17 (56.66%) patients which had presence of hoarseness of voice and 13 (43.33%) patients had no problem with voice. Moreover, on the 7th day, there were only 2 (6.66%) patients which were present with hoarseness of voice and 28 (93.33%) patients had no problem with hoarseness of voice. These results were similar to a study conducted by Sharma *et al*.[1] in which they found that out of 20 patients, only 1 patient (5%) had hoarseness of voice on day 8 after treatment.

On day 0, mean value of swelling size was 45.66 mm which was gradually decreasing on day 3 (22.1 mm) and day 7 (3.96 mm) following treatment, and mouth opening was gradually increasing from day 0 (25.8 mm) to day 3 (36.7 mm) and day 7 (41.23 mm). Hence, from day 0 to day 7, the size of the swelling decreased, while the mouth opening gradually increased. The improvement in the mean change in the mouth opening was also seen on subsequent days with high significance ($P < 0.01$). Mean value of CRP levels on day 0 was 51.58 mg/L which was subsequently reduced on day 3 (23.79 mg/L) and day 7 (7.20 mg/L).

These results were similar to a study conducted by Pinilla *et al*.[14] where they found that CRP levels were significantly high in most of patients of space infections of odontogenic origin. Pepys and Hirschfield[15] also found an excellent correlation of circulating CRP concentrations with the severity, extent, and progression of the disease process.

The statistical analysis explained the direct and linear relation between CRP and size of swelling. The data for mouth opening explained an inverse relation between CRP and mouth opening.

All the 30 (100%) patients were present with pus discharge on the day 0 and after the treatment and antibiotics were given, on day 3, there were 17 (56.66%) patients who had pus discharge and there was absence of pus discharge of all the 30 (100%) patients on the 7th day. These findings were similar to a study conducted by Sharma *et al*.[1] where the data showed that none of patients included in study had discharge present on day 8 after the treatment.

Sabel and Wadsworth[16] conducted studies in the early diagnosis of acute infections and emphasized that CRP can be used for early stage detection of infection. They also concluded that antibiotics usually can be withdrawn if the clinical condition of the patient was satisfactory, and if the CRP levels were not above normal limits.

Similar findings were reported by Ren and Malmstrom[17] and Ylijoki[7] which showed that CRP levels decline significantly when effective treatment was given to the patient.

Seppanen *et al*.[18] found that patients without preceding treatment had the highest CRP levels and WBC counts and that the length of stay of such patients was also longer, more often needing intensive care than the other patients.

The above statistical analysis finds strong correlation between laboratory values of marker with clinical parameters used to measure severity of infection. The analysis also proved that values of marker significantly changed and moved toward normal as the condition of patient improved with effective treatment. Thus, study proved that CRP is significant predictors of severity of infection and effectiveness of treatment regime.

CONCLUSION

Serum CRP has advantage over the traditional strategy of measuring the ESR and WBC counts, by its characteristic feature of rapid rise and fall with the inflammatory process. Hence, measurement of serum CRP is useful to monitor the acute-phase response in clinical practice. Available literatures and our study indicate that measurement of CRP concentration is useful in clinical settings, including monitoring infections and for assessing effectiveness of treatment during the course of a disease. We have analyzed that CRP values and various clinical parameters such as grades of dysphagia, hoarseness of voice were, swelling size, number of spaces, pus discharge, and mouth opening correlated with each other. CRP levels should be incorporated as monitoring tools for managing patients with odontogenic infections and further investigation can be carried out of

CRP with WBC and ESR for more effective monitoring of odontogenic infections.

REFERENCES

1. Sharma A, Gokkulakrishnan S, Shahi AK, Kumar V. Efficacy of serum CRP levels as monitoring tools for patients with fascial space infections of odontogenic origin: A clinicobiochemical study. Natl J Maxillofac Surg 2012;3:148-51.
2. Vincent JL, Donadello K, Schmit X. Biomarkers in the critically ill patient: C-reactive protein. Crit Care Clin 2011;27:241-51.
3. Singh WT, Singh WR, Devi WM, Devi NA. C-reactive protein as a monitoring tool for facial space infections of odontogenic origin: A prospective study. Int J Contemp Dent 2012;3:18-22.
4. Epstein FH, Gabay C, Kushner I. Acute-phase proteins and other systemic responses to inflammation. N Engl J Med 1999;340:448-54.
5. Clyne B, Olshaker JS. The C-reactive protein. J Emerg Med 1999;17:1019-25.
6. Du Clos TW. Function of C-reactive protein. Ann Med 2000;32:274-8.
7. Ylijoki S, Suuronen R, Somer JH, Meurman JH, Lindqvist C. Differences between patients with or without the need for intensive care due to severe odontogenic infections. J Oral Maxillofac Surg 2001;59:867-72.
8. Gibson GB, Blasberg B, Hill SJ. A prospective survey of hospital ambulatory dental emergencies. Part 1: Patient and emergency characteristics. Spec Care Dentist 1993;13:61-5.
9. Khan MH, Smith PN, Rao N, Donaldson WF. Serum C-reactive protein levels correlate with clinical response in patients treated with antibiotics for wound infections after spinal surgery. Spine J 2006;6:311-5.
10. Bilgen O, Atici T, Durak K, Gullari K, Bilgen MS. C-reactive protein values and erythrocyte sedimentation rates after total hip and total knee arthroplasty. J Int Med Res 2001;29:7-12.
11. Margheritini F, Camillieri G, Mancini L, Mariani PP. C-reactive protein and erythrocyte sedimentation rate changes following arthroscopically assisted anterior cruciate ligament reconstruction. Knee Surg Sports Traumatol Arthrosc 2001;9:343-5.
12. Korppi M, Kosma HT, Leinonen M. White blood cells. C-reactive protein and erythrocyte sedimentation rate in pneumococcal pneumonia in children. Eur Respir J 1997;10:1125-9.
13. Pepys MB, Hirschfield GM. C-reactive protein: A critical update. J Clin Invest 2003;111:1805-12.
14. Pinilla JC, Hayes P, Laverty W, Arnold C, Laxdal V. The C-reactive protein to prealbumin ratio correlates with the severity of multiple organ dysfunction. Surgery 1998;124:799-805.
15. Pepys MB, Hirschfield GM, Tennent GA. Targeting C-reactive protein for the treatment of cardiovascular disease. Nature 2006;440:1217-21.
16. Sabel KG, Wadsworth C. C-reactive protein in early diagnosis of neonatal septicemia. Act Pediatric Scand 1978;68:825-35.
17. Ren YF, Malmstrom HS. Rapid quantitative determination of C-reactive protein at chair side in dental emergency patients. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007;104:49-55.
18. Seppanen L, Lemberg KK, Lauhio A. Is dental treatment of an infected tooth a risk factor for locally invasive spread of infection? J Oral Maxillofac Surg 2011;69:986-93.

How to cite this article: Mehta D, Madan S, Prajapati TH, Shah SP, Mistry E, Shah SD. Serum C-Reactive protein as a Monitoring Tool for Odontogenic Infections: A Prospective Study. Int J Sci Stud 2021;9(5):56-60.

Source of Support: Nil, **Conflicts of Interest:** None declared.