Research

Procalcitonin thresholds and early mortality risk in deep neck abscess: a clinical perspective

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ABSTRACT

Background: Procalcitonin (PCT) is widely used as an inflammatory marker in sepsis, but still controversial in deep neck abscesses. **Purpose:** To evaluate the usefulness of PCT as outcome predictor in deep neck abscess. **Method:** A prospective observational cohort study was conducted at Dr. M. Djamil Hospital, Padang, Indonesia (March 2022–May 2023). Patients with confirmed deep neck abscess by pus aspiration in the Emergency Department were included. Baseline laboratory and serum PCT tests were performed before surgical drainage. All patients received broad-spectrum antibiotics and standard postoperative care. Assessed outcomes were mortality, septic shock, organ failure, mediastinitis, empyema/pleural effusion, necrotizing fasciitis, tracheostomy, pharyngocutaneous fistula, Intensive Care Unit >24 hours, and hospital stay. **Result:** Thirty-five patients met inclusion criteria. Multiple neck space involvement was found in 74.3%, and 93.4% underwent surgery. Mortality occurred in 28.6%, septic shock in 20%, mediastinitis in 14.3%, empyema/pleural effusion in 11.4%, necrotizing fasciitis in 8.6%, tracheostomy in 5.7%, fistula in 8.6%, and ICU stay >24 hours in 20%. Mean hospital stay was 9.03±7.90 days. Mean admission PCT was 0.313±0.677 ng/mL, with 17.1% having elevated PCT>0.5 ng/mL. No significant correlation was found between PCT and overall outcome. However, Receiver Operating Characteristic (ROC) analysis showed PCT≥0.14 ng/mL, predicted <5-day mortality (sensitivity 85.7%, specificity 78.4%), Area Under Curve (AUC) 0.773, p=0.027). **Conclusion:** Procalcitonin showed potential as an adjunctive marker in deep neck abscess. Although low initial levels are frequent, they do not exclude severe complications, highlighting its role in early risk stratification and clinical decisions.

Keywords: deep neck abscess, procalcitonin, mediastinitis

ABSTRAK

Latar belakang: *Procalcitonin (PCT) banyak digunakan sebagai penanda inflamasi pada sepsis, namun, pada kasus abses leher dalam masih kontroversial.* ***Tujuan:*** *Menilai kegunaan PCT sebagai prediktor luaran pada abses leher dalam.* ***Metode:*** *Penelitian kohort prospektif observasional di Rumah Sakit Dr. M. Djamil, Padang, Indonesia (Maret 2022-Mei 2023). Sampel adalah pasien dengan abses leher dalam yang dikonfirmasi melalui aspirasi pus di instalasi gawat darurat (IGD). Pemeriksaan laboratorium rutin dan tes PCT serum dilakukan sebelum intervensi bedah. Pasien kemudian ditatalaksana dengan pemberian antibiotik empiris spektrum luas, dan perawatan pasca-operasi standar. Luaran yang dinilai meliputi: mortalitas, syok septik, kegagalan organ, mediastinitis, empiema/efusi pleura,* fasciitis *nekrotikans servikal, trakeostomi, fistula faringokutan, rawat IGD>24 jam, dan lama rawat inap.* ***Hasil:*** *Sebanyak 35 pasien dengan abses leher dalam memenuhi kriteria inklusi. Keterlibatan multi ruang leher ditemukan pada 74,3%, dan 93,4% kasus menjalani pembedahan. Mortalitas terjadi 28,6%, syok septik 20%, mediastinitis 14,3%, empiema/efusi pleura 11,4%,* fasciitis *nekrotikans 8,6%, trakeostomi 5,7%, fistula 8,6%, rawat IGD>24 jam 20%. Rerata lama perawatan 9,03±7,90 hari. Rerata kadar PCT awal 0,313±0,677 ng/mL, dengan 17,1% kasus menunjukkan peningkatan PCT>0,5*

ng/mL. Tidak ditemukan hubungan antara PCT dan luaran keseluruhan. Namun, analisis kurva ROC *menunjukkan nilai PCT≥0,14 ng/mL memprediksi mortalitas <5 hari (sensitivitas: 85,7%, spesifisitas: 78,4%, AUC (Area Dibawah Kurva): 0,773, p=0,027).* ***Kesimpulan:*** *PCT berpotensi sebagai penanda tambahan pada kasus abses leher dalam. Meskipun kadar awal rendah sering ditemukan, namun tidak menyingkirkan risiko komplikasi berat, sehingga menegaskan perannya dalam stratifikasi risiko dini dan pengambilan keputusan klinis.*

Kata kunci: *abses leher dalam, procalcitonin, mediastinitis*

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INTRODUCTION

Deep neck abscesses (DNA) are severe infections characterized by pus accumulation, potentially involving multiple deep neck spaces. They can cause life-threatening complications, such as upper airway obstruction, mediastinitis, Lemierre's syndrome, carotid artery aneurysm or rupture, cervical necrotizing fasciitis, and pneumonia.[1] Managing DNA remains challenging due to: Complex neck anatomy, complicating infection localization; Deep-seated spaces that may leave superficial tissues unaffected, delaying diagnosis; Risk to vital neurovascular structures during surgical access; Potential residual complications, such as nerve dysfunction, vascular erosion, or osteomyelitis, due to surrounding tissue involvement; and connection of deep neck spaces with other potential spaces, like the mediastinum, increasing the risk of extra cervical infections.[1,2]

Systemic inflammatory markers are needed alongside clinical assessment to gauge disease severity, predict complications, and guide prognosis. Procalcitonin (PCT) has been recommended as an additional marker in sepsis cases, demonstrating high sensitivity in early detection of sepsis, and prediction of fatal outcomes in critically ill patients. PCT is also used to guide antibiotic cessation and differentiate bacterial from viral infections.[3,4]

In DNA cases, studies on PCT remain limited. Kameshwar et al.[5] reported that elevated PCT levels correlate with prolonged hospital stays in DNA patients.

This study aimed to evaluate the correlation between PCT levels and outcomes in DNA, while also providing data on patient characteristics and management outcomes at Dr. M. Djamil Hospital, Padang, to improve future treatment protocols.

METHOD

This study was a prospective observational cohort conducted at Dr. M. Djamil Hospital, Padang, Indonesia, from March 2022 to May 2023. The sample population included patients diagnosed with deep neck abscess (DNA), confirmed via pus aspiration under local anaesthesia in the Emergency Department.

The inclusion criteria were patients with a primary diagnosis of deep neck abscess treated at Dr. M. Djamil Hospital, aged 18 old and above. The exclusion criteria were: uncomplicated peritonsillar abscess; superficial abscess or lymph node abscess; post-traumatic infections; and head and neck malignancies.

Routine laboratory tests and serum procalcitonin (PCT) levels were measured before surgical interventions, such as incision

and drainage, with or without additional procedures like necrotomy or sternotomy. Patients were treated according to hospital protocols, including broad-spectrum empirical antibiotics, postoperative wound care, and supportive therapies as needed.

Patient outcomes were tracked until discharge, based on predefined criteria. Assessed outcomes included mortality, septic shock, organ failure, mediastinitis, empyema/pleural effusion, cervical necrotizing fasciitis, tracheostomy, pharyngocutaneous fistula, ICU stay >24 hours, and length of hospital stay.

This study was approved by the Health Research Ethics Committee of Dr. M. Djamil General Hospital, Padang, under ethical clearance number LB.02.02/5.7/332/2022.

RESULT

A total of 35 patients with deep neck abscess met the inclusion criteria.

Table 1. Characteristics (n=35)

Variable	n	%
Gender		
Male	29	82.9
Female	6	17.1
Mean Age	47.31±16.376	
Age Group		
18–40 years	14	40.0
40–65 years	12	34.3
>65 years	9	25.7
Comorbidities*	15	42.9
Diabetes Mellitus	12	34.3
Hypertension	9	25.7

Based on Table 1, deep neck abscess cases were predominantly male, with a male-to-female ratio of approximately 4.5:1 (29 male cases vs. 6 female cases). The mean age of patients was 47.31 years, with the youngest being 19 years old and the oldest 75 years old. The most common age group was 18–40 years. Additionally, 42.9% of cases had comorbidities, with diabetes mellitus being the most frequent (34.3%).

Table 2. Symptoms and signs of respondents

Variable (N=35)	n	%
Onset of Disease Before Admission (mean)	6.03±3.87	
Onset of disease <7 days	21	60.0
Onset of disease ≥7 days	14	40.0
Clinical Symptoms*		
Difficulty opening mouth	31	88.6
Swelling	35	100.0
Odynophagia	18	51.4
Neck movement pain	12	34.3
Salty taste in mouth	18	51.4
Chest pain	7	20.0
Shortness of breath/dyspnea	5	14.3
Fever	31	88.6
Previous toothache	32	91.4
Clinical Signs*		
Trismus	32	91.4
Tenderness/swelling	35	100.0
Fluctuation	35	100.0
Positive aspiration	35	100.0
Crepitation	7	20.0
Treatment >7 days	15	42.9
ICU stay >24 hours	7	20.0
Mean length of stay (days)	9.03±7.90	

*Note: A patient may present with more than one

The mean onset of disease before admission was 6.03±3.87 days, with 60% of cases presenting within 7 days, and 40% after 7 days. Swelling was reported by all patients (100%), followed by difficulty opening the mouth (88.6%), fever (88.6%), and toothache history (91.4%). Other symptoms included odynophagia (51.4%), neck movement pain (34.3%), chest pain (20%), and dyspnea (14.3%). Clinical signs were consistent with deep neck abscess, including swelling, fluctuation, and positive pus aspiration, observed in all cases. Trismus occurred in 91.4% of patients, while crepitation was noted in 20%. Prolonged hospitalization

(>7 days) occurred in 42.9% of cases, with 20% requiring ICU stays over 24 hours. The mean hospital stay was 9.03±7.90 days, ranging from 1 to 31 days.

Tabel 3. Involved potential neck spaces (n=35)

Variable	n	%
Distribution of Involved Potential Spaces*		
Submandibular	33	94.3
Submental	18	51.4
Sublingual	7	20.0
Parapharyngeal	8	22.9
Retropharyngeal	5	14.3
Paratracheal	8	24.2
Buccal/Masticator	8	22.9
Suprasternal	9	25.7
Peritonsillar	1	2.9
Number of Involved Spaces		
Single space involvement	9	25.7
Multiple space involvement	26	74.3
2–3 spaces	17	48.6
≥4 spaces	9	25.7

*Note: A patient may present with more than one space involved.

The majority cases (94.3%) involved the submandibular space, followed by the submental (51.4%) and suprasternal spaces (25.7%). Multiple-space involvement was observed in 74.3% of cases, with 48.6% involving 2–3 spaces, and 25.7% involving ≥4 spaces. In contrast, only 25.7% of cases were confined to a single space.

A total of 51.7% of deep neck abscess cases experienced complications, while 42.9% showed no complications. Mortality occurred in 10 cases (28.6%), and septic shock/organ failure was observed in 8 cases (22.8%). Mediastinitis was reported in 5 cases (14.3%), and pleural effusion/empyema in 4 cases (11.4%). Tracheostomy was performed in 2 cases (5.7%). Other complications included necrotizing fasciitis (3 cases, 8.6%), pharyngocutaneous fistula (3 cases, 8.6%), and neurovascular injury (3 cases, 8.6%), specifically involving the mandibular branch of the facial nerve. Early mortality (≤5 days) occurred in 5 cases (14.3%).

Table 4. Distribution of complications in deep neck abscess patients*

Variable (n=35)	n	%
Complications (Overall)	18	51.7
No Complications	15	42.9
Mortality	10	28.6
Septic shock/organ failure	8	22.8
Pleural effusion/empyema	4	11.4
Mediastinitis	5	14.3
Airway obstruction requiring tracheostomy	2	5.7
Necrotizing fasciitis	3	8.6
Pharyngocutaneous fistula	3	8.6
Neurovascular injury	3	8.6
Early mortality (≤5 days)	5	14.3

*Note: A patient may present with more than one subcategory.

Table 5. Correlation between procalcitonin and outcomes in deep neck abscess (Chi-square test)

Procalcitonin (ng/mL)	No complications	With complications	p	OR (95% CI)
<0,5	17 (58.6%)	12 (41.4%)	1.000	1.417 (0.243–8.256)
≥0.5	3 (50.0%)	3 (50.0%)		

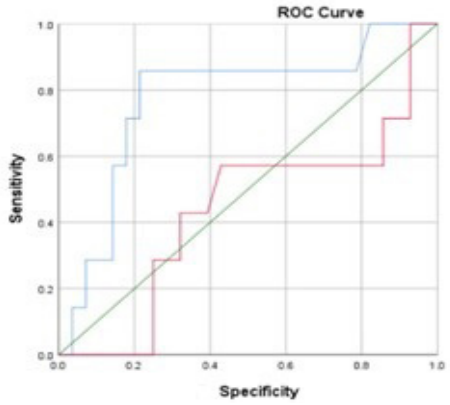

Figure 1. ROC Curve

In the group with elevated procalcitonin levels (≥0.5 ng/mL), 3 cases (50%) experienced complications, while the other 3 cases (50%) did not. Similarly, among cases with procalcitonin levels <0.5 ng/mL, 12 cases (41.4%) also experienced complications. Based on the table above, there was no significant correlation between procalcitonin levels and outcomes in deep neck abscess ($p > 0.05$).

The Receiver Operating Characteristic (ROC) curve analysis evaluated the ability of Procalcitonin (PCT) and Neutrophil-to-Lymphocyte Ratio (NLR) to predict early mortality (<5 days) in patients with deep neck abscess. PCT demonstrated a fair predictive performance, with an Area Under the Curve (AUC) of 0.773 (95% CI: 0.567–0.979, p=0.027). Conversely, the Neutrophil-to-Lymphocyte Ratio (NLR) showed poor predictive value for early mortality, with an AUC of 0.436 (95% CI: 0.186–0.686, p=0.606). Further analysis identified a PCT threshold of ≥0.14 ng/mL as associated with early mortality risk in patients with deep neck abscess. At this cut-off value, PCT demonstrated a sensitivity of 85.7% and a specificity of 78.4%, with an AUC of 0.773 (p=0.027).

DISCUSSION

The majority of deep neck abscess (DNA) cases were male (82.9%), with females comprising 17.1%, consistent with other studies reporting 60–80% male predominance.[6,7] The mean age in this study was 47.31±16.376 years, aligning with Trevino et al.[6], who reported a mean age of 41.79±15.48 years. Advanced age is associated with higher complication rates, prolonged hospital stays, and increased reoperation rates.[8] Suetrong et al.[9] found that patients >65 years had a 2.87-fold higher risk of complications (OR=2.87).

Nearly half of the patients (42.9%) had comorbidities, most commonly diabetes mellitus (34.3%) and hypertension (25.7%). This aligns with Almutairi et al.[10], who reported comorbidities in 50% of DNA cases, with diabetes in 45.2% and hypertension in 23.7%.[10,11] Ho et al.[12] reported that 41.98% of cases undergoing incision and drainage had diabetes. Comorbidities like diabetes, chronic obstructive pulmonary disease (COPD), anemia, chronic kidney disease, and malnutrition, significantly increased the risk of complications. Suetrong et al.[9] reported that diabetes raised the risk of complications (OR=4.97).

Submandibular space involvement was the most common (94.3%), followed by submental space (51.4%). The mandibular roots' proximity to the submandibular space facilitates infection spread to adjacent areas, such as the parapharyngeal and submental spaces.[6,13,14] Retropharyngeal infections can extend to the mediastinum, increasing the risk of septic shock (OR=10.7).[15] In our study, multiple deep neck space involvement was found in 74.3% of cases, with complications occurring in 88.5% of these cases. This proportion is higher than Trevino et al.[6], who reported 36% multiple-space involvement.

Complications, both regional and systemic, were observed in 71.4% of patients, higher than the 10–40% reported in other studies.[8,16] For example, an Italian study reported an 18.3% complication rate with a mortality rate of 0.3%,[17] while a Latvian study found 11.4% complications.[8] In developing countries like Mexico, complication rates were 28%.[6] Arianto et al.[16] in Indonesia reported complications in 40% of DNA cases. The high complication rate in this study may reflect the exclusion of simpler cases, such as peritonsillar abscess or cellulitis, resulting in a higher proportion of severe cases.

Correlation of Procalcitonin and outcomes

This study found that mean admission procalcitonin (PCT) levels in deep neck abscess (DNA) cases were low at 0.313±0.677 ng/mL, with only 6 cases (17.1%) showing PCT≥0.5 ng/mL. Complications were observed in 71.4% of cases, yet no significant correlation was identified between admission PCT levels and patient outcomes. These findings highlight the limited predictive value of PCT in this cohort, particularly in the presence of prior treatments that might alter systemic inflammatory responses.

Kim et al.[18] demonstrated higher PCT levels in odontogenic infections associated with sepsis, with diagnostic accuracy reaching 83.33% sensitivity and 85.71% specificity (cut-off: 0.5 ng/mL). However, our study aligned more closely with Bertolus et al.[19], who also reported low PCT levels in odontogenic infections, with only 9% of cases exceeding 0.25 ng/mL. PCT values may remain low in localized infections or in patients who received corticosteroids, NSAIDs, or antibiotics before admission, as observed in 60% of cases in this study.[19-21] This underscored the complexity of interpreting PCT levels in clinical settings.

Although this study found no association between admission PCT levels and complications, Kameshwar et al.[22] demonstrated a correlation between rising post-treatment PCT levels and complications, including mediastinitis and re-exploration, in 33% of cases. Differences in inclusion criteria, in Kameshwar's study heeding to peritonsillar abscesses (18.1%) and predominantly single-space involvement (81.1%), likely explained the lower complication rates compared to this study, which focused on more severe cases with multiple-space involvement.

ROC analysis in our study revealed that PCT≥.014 ng/mL moderately predicted <5-day mortality, with 85.7% sensitivity and 78.4% specificity (AUC: 0.773, p=0.027). These findings suggest that while PCT might offer some predictive utility for early mortality, its role in risk stratification was limited. This was consistent with studies by Suranadi et al.[23] and Liu et al.[24], which reported PCT as an independent predictor of 28-day mortality in sepsis patients.

Procalcitonin levels, although not always reflective of the clinical severity of deep neck abscesses, demonstrate potential as a valuable predictor of fatal complications. This study highlighted the ability of PCT to moderately predict early mortality (<5 days) with high sensitivity and specificity, particularly at a threshold of ≥0.14 ng/mL. These findings supported the inclusion of PCT as an adjunctive marker in the risk stratification of deep neck abscess cases.

While low initial PCT levels were common, especially in patients with prior treatment, clinicians should remain vigilant as such cases did not eliminate the possibility of severe outcomes. Incorporating PCT into clinical protocols can enhance early decision-making, complementing existing diagnostic and therapeutic strategies to improve patient outcomes.

In conclusion, Procalcitonin shows potential as a useful predictor of fatal complications in deep neck abscesses, particularly for early mortality (<5 days) with high sensitivity and specificity at a threshold of ≥0.14 ng/mL. While low initial levels are common, they do not exclude severe outcomes, underscoring PCT's role as an adjunctive marker in risk stratification and clinical decision-making.

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