Clinico-Pathological Profile of Deep Neck Space Infection: A Prospective Study

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Abstract Deep neck space infections (DNI) has been a common and serious disease, involving several spaces created by planes of greater and lesser resistance between the fascial layers of the neck. Infection of deep neck space has been dangerous due to its potential ease of spread from one space to other space, associated sepsis and upper airway obstruction. This prospective study was done in 45 patients of DNI over a period of 1 year. Patients with age of 1 month to 80 years of both the sexes were included. Patient's particular, clinical presentation and associated co-morbid conditions, physical examination, routine laboratory investigations and radiological investigations were analyzed. Patients were treated, response to the treatment was assessed and follow-up was done. In present study, DNI was more commonly seen in rural population (67%) with a male predominance (69%). Mean age of presentation was 34.4 years. Odontogenic infection (64.11%) was the commonest etiological factor and diabetes mellitus (26.66%) was the commonest co-morbid condition. Most common presenting symptom was neck pain and neck swelling (91.1%) and submandibular space (66.6%) was the most commonly involved space followed by sublingual space (44.6%). Both medical and surgical treatment was needed in most of the

cases (77.77%). 77.7% cases showed complete regression, 15.5% showed partial regression and they lost to follow-up, 4.4% expired and 2.2% showed progressive deterioration. DNI is a common and life-threatening disease. Early diagnosis and management is necessary for complete cure and to prevent complications associated with DNIs.

Keywords Deep neck space infection · Deep neck space · Odontogenic infection · Upper airway obstruction · Submandibular space

Introduction

Deep neck space infections (DNI) were known since the time of Galen in second century A.D. Infections of deep neck spaces has been a common challenging problem due to its complex anatomy, deep location, difficult access, proximity to other neurovascular structures and communication of one space to other and also with areas outside the head and neck (e.g. mediastinum and coccyx). The diagnosis and treatment of infections in this area was very difficult in the past and was associated with high morbidity and mortality. The complication rate has been reduced in recent years due to the advent of modern microbiology, development of sophisticated diagnostic tools, availability of effective antibiotics and development of medical intensive care protocols and surgical techniques.

Methods

Present study was made to analyze the perspectives of DNI in the population of northern India. This prospective study was carried out in the department of otorhinolaryngology,

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King George Medical University, Lucknow from September 2008 to August 2009. The study subjects were selected among the patients admitted in the department of otorhinolaryngology. The patients suffering from DNIs were screened on the basis of history, clinical examination and relevant investigations. The patients with the age of 1 month to 80 years of both the sexes who were willing for admission and complete treatment and follow up were included in the study. Neonates, pregnant females and uncooperative patients were excluded from the study.

Patient's particulars, antecedent illness, clinical presentation, physical examination, laboratory evaluation and radiological findings were analyzed (Table 1).

A broad spectrum antibiotic was started initially and changed according to culture and sensitivity report. Aspiration and surgical drainage of the pus was done whenever needed. Response to the treatment was assessed on the basis of general condition of the patient, percentage regression of the swelling clinically and improvement in opening the mouth. Follow up was done at 1 week and 1 month intervals to see the residual/recurrence of disease. Serial photograph was taken at the time of admission and weekly thereafter.

Data for outcome assessment including duration of hospital stay, condition of patient at the time of discharge and complications were recorded and statistically analyzed. The analysis was done on 'Microstat' statistical analysis software and values were represented in numbers (%) and Mean. Statistical significance was also analyzed.

Observation and Result

During the 1 year study period, total 45 patients of DNI were diagnosed and treated. Most common age of presentation was 2nd decade of life; however no significant difference in number of patients in different age group was observed in the present study ($p = 0.5$) (Fig. 1a). Mean age of presentation was 34.84 years.

Males significantly outnumbered females (31 males and 14 females) with male to female ratio being 2.2:1 ($p < 0.001$). Occupation wise DNI was significantly more prevalent in farmers; followed by laborers amongst the males ($p < 0.05$) (Fig. 1b). Hindus (39/45) were significantly more affected than Muslims (6/45) ($p < 0.001$). There was no case of DNI from Sikh, Christian or Jain community.

One third of the patients were from urban area (15/45); whereas 2/3rd from rural area (30/45). Rural distribution was significantly higher ($p < 0.01$).

Sudden onset was seen in one third of the patients while other showed insidious onset. Insidious onset of the disease was significantly higher than sudden ($p < 0.01$).

Thirty five out of 45 patients of DNI revealed personal habits of smoking, tobacco chewing or alcohol consumption. Ten patients had no history of smoking, tobacco chewing or alcohol consumption.

Associated co-morbid condition was found in 21 out of 45 patients. There was no significant difference seen in patients with or without co-morbid conditions ($p = 0.15$). The most common co-morbid condition observed was diabetes mellitus (26.66%), followed by hypertension (11.11%). Blunt trauma of neck was associated with three cases (6.66%) and one case had accidental trauma of oropharynx due to injury by fish bone (2.22%). None revealed any past history of tuberculosis, AIDS or any immunocompromised state. Mean age of presentation of non-diabetic patients were 29.5 years and diabetic patients were 52.14 years and it was significantly higher ($p < 0.001$).

Clinical presentation differed from patient to patient. The most common presenting symptom was neck pain and neck swelling. The most common physical finding on admission was swelling of neck, pain or stiffness during passive movement of neck and varying degree of trismus (Table 2).

Duration of illness varied from 7 days to 8 weeks. Patients presented most commonly in the first week (15/45), followed by second week (14/45) and third week (10/45). Four patients presented in fourth week and two patients between fifth and eighth weeks.

Etiologically, most common etiological factor associated with DNI was dental infection (25), followed by upper respiratory tract infection (URTI) (08), trauma (05) {blunt trauma (04) and trauma by fish bone (01)}, congenital sinus (01) and malignancy (01). No etiological association was found in six patients (Fig. 1c). Odontogenic infection was the most common cause of DNI in both diabetics and non-diabetics. 90.9% of diabetic patients had a history of odontogenic infection; however only 44.11% of non-diabetics had a history of odontogenic infection.

Submandibular space (66.6%) involvement was most commonly found. The most common bilaterally involved space was also the submandibular space. Sublingual space (44.6%), parotid space (40.0%) and anterior visceral space (40.4%) was the second, third and fourth most common spaces involved. Simultaneous involvement of multiple spaces was found in most of the cases. Only one case associated with hypertension had carotid space involvement whereas no involvement of danger space or paravertebral space was encountered (Table 3). Patients presented in the first week of their illness were commonly presented with submandibular space involvement, whereas patients with late presentation (between 1 and 2 weeks) had common parapharyngeal and retropharyngeal space involvement.

Table 1 Details of patent analysis

(A) Details of patient history	
1. Patient's particulars	Age, sex, address, occupation, religion, marital status
2. Family history	Present/absent
3. Personal history	Smoking with amount in a day and duration (number of years), alcohol consumption with amount and duration (number of years), tobacco chewing with amount and duration (number in years), history of immunization
4. Past history	Diabetes, hypertension, tuberculosis, immunosuppression (e.g. HIV, leukemia, immunosuppressive drug intake), any congenital anomaly (e.g. branchial cyst, thyroglossal cyst), neck trauma (blunt or penetrating)
5. Treatment history	Presence of any relevant treatment history
6. Preceding symptoms	Neck pain, toothache, sore throat, swelling, difficulty in swallowing, trismus, dyspnea, fever, speech difficulty, neck mobility
(B) Details of patient examination	
1. Physical examination	(a) General examination: pulse, blood pressure, respiratory rate, temperature, pallor, icterus, cervical lymphadenopathy, neck mobility (b) Systemic examination: respiratory system, cardiovascular system, gastro-intestinal system, nervous system
2. Complete otorhinolaryngological examination	(a) Oral cavity: degree of mouth opening, oral hygiene, dental caries, (b) Oropharynx: condition of tonsil, soft palate, posterior and lateral pharyngeal wall, base of tongue for inflammation, medial bulge and any growth, (c) Hypopharynx and larynx, (d) Nose and ear
3. Local examination	(a) Inspection: site, size, shape, surface, pulsation, movement with deglutination and protrusion of tongue, skin over the swelling (b) Palpation: site, size, shape, surface, extent, edge, temperature, tenderness, consistency, translucency, fluctuation, reducibility, impulse on coughing, fixity to overlying skin and relation to surrounding structures (c) Auscultation: for bruit or venous hum
(C) Details of investigations done	
1. General investigations	Hb, TLC, DLC, platelet count, blood sugar, serum sodium, potassium, calcium, urea, creatinine, bleeding time
2. Radiological investigations	(a) X-ray neck lateral view: interpreted by measuring the distance from anterior aspect of vertebral body to the air column of the posterior pharyngeal wall (distance >1.5 times the width was classified as widened) (b) X-ray chest AP view: to see mediastinal involvement as mediastinal widening (c) Orthopantomography: to see dental caries whenever required (d) Ultrasonography: to differentiate abscess from mass, guided FNA of lymphnode (e) CT scan neck: both plain and contrast (hypodense ± ring enhancement: phlegmon/cellulitis; hypodense + complete ring enhancement: abscess) (f) MRI: whenever needed
3. Microbiological investigations	Culture and sensitivity of aspirated pus

Routine hematological investigation was done in 43 out of 45 cases. One patient presented with respiratory distress and died soon after admission and one patient absconded after admission (Table 4).

Pus sample was aspirated from 30 out of 45 patients and culture and sensitivity was done from all of them. 60% (18/30) samples were sterile after 48 h of incubation. The most common microorganism identified was *Staphylococcus aureus* (04), followed by *Enterococcus* spp. (03). Other organisms identified were *Streptococcus viridians* (01), *Klebsiella pneumonia* (01), *E. coli* (01), Diptheroid (01)

and nonhemolytic *Streptococci* (01) (Fig. 1d). Surprisingly, the retropharyngeal space infections were mostly sterile and one case revealed *K. pneumoniae*.

Radiological investigations {Ultrasonography (USG)/CT scan} were performed in 27 (60%) patients. In none of the patients, USG and CT were performed at a same time. USG was done in six (22.22%) cases and CT scan was done in 21 (77.77%) cases. Both USG and CT scan showed the neck space involvement, extent of the disease and they also differentiated cellulitis from abscess formation (Figs. 2a–f, 3b, e).

Fig. 1 **a** Details of age distribution. **b** Distribution of occupation in cases of DNI. **c** Details of etiological association. **d** Details of bacteriological association in cases of DNI

Table 2 Details of clinical presentation

Clinical feature	Number of cases (n = 45)	%
Neck pain	41	91.1
Neck swelling	41	91.1
Dysphagia	40	88.6
Speech difficulty	33	73.3
Trismus	30	66.6
Toothache	25	55.5
Limited neck mobility	23	51.1
Dyspnea	19	42.2
Fever	04	8.8
Sore throat	03	6.6
Lymphadenopathy	03	6.6

All the patients were treated either medically and/or surgically. Treatment was started as the patient presented to us, with broad spectrum antibiotics (Ceftriaxone, Amikacine and metronidazole) and changed accordingly after the culture and sensitivity report. Ten patients (22.22%) were treated with intravenous (I.V) antibiotics and other supportive drugs. Surgical intervention in the form of aspiration and/or incision and drainage was required in significantly high number (77.77%) of cases ($p < 0.001$). Intubation was needed in one patient (2.22%) and tracheotomy in one patient (2.22%).

Significant number of patients {18 (40%) out of 45} stayed in the hospital for 1–2 weeks ($p < 0.001$). Duration

of hospital stay ranges from 01 to 55 days and the mean duration of hospital stay was 17.13 days. Two patients were expired; one soon after admission and another on 2nd day of admission. Mean duration of hospital stay for younger than 50 years were 15.12 days, whereas mean duration of hospital stay for patients with >50 years was 22.66 days (Table 5). Diabetic patients had a longer duration of hospital stay than non-diabetics (24.83 days for diabetics and 14.17 days for non-diabetics).

Thirty five (77.7%) patients out of 45 responded completely (Fig. 3a vs. c and 3d vs. f) Seven (15.5%) patients responded partially and they left the treatment. One patient with progressive deterioration discontinued the treatment. Death occurred in two patients. Patients were followed at the interval of 1 week and at 1 month period. No recurrence was observed in 35 out of 45 patients which was significantly high ($p < 0.001$). Seven patients absconded after a partial response and could not be followed up. One patient with malignancy of lateral pharyngeal wall showed progressive deterioration (Table 6).

Discussion

Demography

Deep neck space infection/abscess has been a commonly encountered condition in developing countries like India. This could be due to lack of awareness, illiteracy, poverty,

Table 3 Details of neck spaces involved

Neck space involved	Number of patients (n)	Percentage (n × 100/45)
Submandibular space	30	66.6
Sublingual space	21	44.6
Parotid space	18	40.0
Anterior visceral space	18	40.0
Masticator space	18	40.0
Buccal space	10	22.2
Para pharyngeal space	08	17.7
Retropharyngeal space	06	13.3
Peritonsillar space	02	4.4
Carotid space	01	2.2

Table 4 Details of laboratory findings

Laboratory findings (normal range)	Normal (%)	Abnormal (%)
Hemoglobin (12–16 gm/dl)	76.6	23.25
TLC (4000–11,000/cumm)	65.10	34.88
DLC (polymorps—50–70%, lymphocytes—20–40%, Eosinophils—2–6%, monocytes—1–3%)		
Platelet count (1.5–3 lakh/cumm)	100	00
Blood sugar (fasting <110 mg/dl, Post prandial <140 mg/dl)	76.74	23.25
Serum Na ⁺ (135–145 mEq/l)	86.03	13.95
Serum K ⁺ (3.5–5.5 mEq/dl)	81.39	9.30
Serum Ca ⁺ (9–11 mg/dl)	83.72	11.62
Serum urea (up to 30 mg/dl)	74.40	25.58
Serum creatinine (<1.5 mg/dl)	79.06	20.90

poor living condition and poor primary health infrastructure [1]. In current study, DNI was significantly prevalent in rural population (66.6%) as compared to urban population (33.3%). This might be due to the large proportion of rural population in India lacking the awareness and proper primary health care.

Males were more commonly affected than the females in the present study. Huang et al. [2] and Paolo et al. [3] also documented the incidence in male as 58.9 and 56.9% in their studies respectively. The male versus female ratio in our study reflected the male dominated society, where females remain confined to their home and are neglected; hence, such females present late to the primary health centre and most of them never come to the tertiary care hospital. The difference might have been partially due to exclusion of pregnant females from our study. In addition, the life expectancy of females appears to be more than males because of their stronger innate immunity.

In present study, the mean age of presentation was found to be 34.84 years, which was different from the other studies done by Huang et al. [2] (49.5 years) and Paolo et al. [3] (49.6 years). This difference may be due to the late expanding phase of demographical cycle of India where 46% of Indian populations belong to below 20 years age group, less life expectancy in India (as compared to developed countries) and small population size in the present study.

Our study showed the incidence of DNI among children (1–15 years) as 24.4% with a mean age of presentation as 9.18 years; however Tan et al. [4] reported the mean age of presentation in children as 5.9 years.

The current study showed that the DNI was common in rural farmers and this was probably because India being an agriculture dominant country, most of the farmers reside in the rural area. Also, most of the patients in the present study were Hindus (86.6%) as compared to Muslims (13.3%). It denoted the dominance of Hindu population in this area.

Etiology

In current study, most common etiological factor associated with DNI was dental infection (64.11%). Daramola et al. [5] and Parhiscar et al. [6] reported the dental infection as the most common etiological factor (49.1 and 43% respectively). However, Huang et al. [2] and Paolo et al. [3] reported the URTI as the most common etiological factor (53 and 47.5% respectively). Etiology was unknown in 13.33% cases in our study. Regueiro et al. [7] and Eftekharian et al. [8] also documented the unknown etiology as 22 and 32.1% cases respectively.

Clinical Presentation

Neck swelling and neck pain were the most common presenting symptoms in the present study. Eftekharian et al. [8] reported neck swelling as the most common presenting symptom (88.4%) and Crespo et al. [9] reported neck swelling as the most common clinical finding.

In children, most common symptom was neck swelling (81.8%) in the present study; however, this was not in concordance with the observation of Liu et al. [10] who reported the most common symptom as fever (93.3%) and swelling of neck (70.0%) as second most common symptom in children. This difference could be due to ignorance of the guardians who neglected the early symptom of DNI until the visible swelling became conspicuous. Also, most of the patients were treated by primary care physicians with injudicious antibiotics that might have controlled the pyrexia and hence, patients presented late to us without having pyrexia.

Fig. 2 **a** CT scan of a patient showing hypointense area left parapharyngeal space (arrow). **b** CT scan of a patient showing hypointense areas in bilateral parapharyngeal spaces (arrow) and retropharyngeal space (curved arrow). **c** CT scan of a patient showing hypointense area in anterior visceral spaces (arrow). **d** CT scan of a

patient showing hypointense area in retropharyngeal space (arrow). **e** USG of a patient showing involvement of parotid space with fluid collection. **f** USG of a patient showing involvement of carotid space with thrombosis of internal jugular vein

Associated Co-morbid Condition

Diabetes mellitus (26.66%) was the most common associated co-morbid condition in the present study. Huang et al. [2] reported 34.1% patients of DNI having associated systemic diseases, out of which 88.9% had diabetes mellitus. Diabetic patients had most common submandibular space involvement, older mean age of presentation, as well as more severe disease with longer duration of hospital stay than non-diabetics in the present study. These findings were similar to another study done by Huang et al. [11] who compared diabetic with non-diabetics and documented that the diabetics had an older mean age of presentation (57.2 vs. 46.2 years) and longer duration of hospital stay (19.7 vs. 10.2 days).

There was no case of primary or acquired immunodeficiency in the present study. This was similar to the study of Eftekharian et al. [8].

In this study, 71.1% patients had history of substance abuse. Similar finding was documented by Daramola et al. [5] (53.7%).

Neck Space Involvement

Submandibular space (66.6%) was the most common involved space in the present study. This finding was similar to the study done by Marioni et al. [12] who reported the submandibular space involvement in 73 out of 85 patients. Similar observation also have been reported by Regueiro et al. [7] and Eftekharian et al. [8] where submandibular space involvement was seen in 29 and 23.3% respectively. Parhiscar et al. [6] reported the lateral pharyngeal space (43%) and Wang et al. [13] reported the peritonsillar space as the most commonly involved space in their studies and these findings were dissimilar to the findings of the present study.

Fig. 3 **a** Clinical photograph of patient-A showing diffuse swelling of lower half of the face (*more over right*) and submandibular region. **b** CT scan of patient-A showing hypointense areas in right masticator space (*curved arrow*) and bilateral submandibular space (*arrow*). **c** Clinical photograph of the same patient (patient-A) after recovery.

d Clinical photograph of patient-B showing diffuse swelling of lower half of the face (*more over right*). **e** CT scan of patient-B showing hypointense areas in bilateral masticator spaces (*curved arrow*). Pus collection can also be seen in the right masticator space. **f** Clinical photograph of the same patient (patient-B) after recovery

Table 5 Duration of hospital stay in different age groups

Age group	Number of patients (n = 45)	Mean duration of hospitalization (days)
1 months–10 years	05	13.6
11–20 years	09	12.7
21–30 years	06	10.3
31–40 years	07	21.0
41–50 years	06	21.3
51–60 years	07	27.4
61–70 years	04	17.0
71–80 years	01	12.0

In our study, anterior visceral space involvement (63.6%) was most commonly seen in children. In contrast, Liu et al. [10] documented both peritonsillar (24.3%) and para-pharyngeal (24.3%) spaces as the most commonly involved deep neck spaces in children. However, Tan et al. [4] reported retropharyngeal space (36.7%) as the most

commonly involved space in children. This difference in pediatric population might be due to small sample size of pediatric population in the current study.

Hematological Investigations and Imaging Study

Hematological investigations were performed in 95.5% cases in the present study. Most of the patients showed normal hematological parameters and this could be due to the treatment given by primary care physicians, who might have masked the systemic abnormalities. Few patients with diabetes mellitus with compromised renal function had deranged serum urea and creatinine.

In present study, USG was done in 22.22% cases and CT scan was done in 77.77% cases. Wetmore et al. [14] reported 92% correlation between CT evidence of an abscess and its surgical confirmation. However, Glasier et al. [15] reported that USG can better diagnose surgically drainable abscess than CT scan. In none of the patients, USG and CT were performed at a same time in our study,

Table 6 Treatment response and follow up

Response to treatment	Number of patients (n = 45)	Percentage (%)
No recurrence	35	77.7
Recurrence	00	00
Absconded	07	15.5
Deterioration	01	2.2
Death	02	4.4

so effectiveness of both the modalities could not be compared.

Bacteriology

60% cultures of the present study were found to be sterile and this was most probably due to injudicious use of antibiotics prior to hospital admission. *S. aureus* (13.33%) was found to be the most common micro-organism. This was similar to the study done by Paolo et al. [3] who also reported *Staphylococcus* (36.9%) as the most common micro-organism. However, Huang et al. [16] reported *S. viridians* (38.3%) as the most common isolated organism. Parhiscar et al. [6] documented the *S. viridians* (39%), *Staphylococcus epidermidis* (22%) and *S. aureus* (22%) as the first, second and third most common isolated micro-organism respectively. Culture for anaerobes was not performed in the present study due to some technical reasons like unavailability of transport media and culture media for anaerobes and hence, the incidence of anaerobic micro-organism might have been under-reported.

Treatment

In present study, all patients were initially treated with broad spectrum I.V antibiotics since DNIs are often polymicrobial. Surgical drainage was required in 77.7% cases. Nearly same requirement was reported by Wang et al. [13] and Marioni et al. [12] where 74.5 and 71.8% cases required surgical drainage respectively. However, Regueiro et al. [7] treated most of his patients with I.V broad spectrum antibiotics and surgical drainage was needed in 54% cases only.

Most of the patients in the current study presented with respiratory distress but, intubation was needed only in one patient (2.22%) who was a 3 years old child with parapharyngeal abscess. Tracheotomy was done in other adult patient (2.22%) with retropharyngeal abscess, having severe respiratory distress. Tracheotomy was needed in 18 and 5.25% cases in the studies done by Regueiro et al. [7] and Kataria et al. [17] respectively.

Duration of Hospital Stay

In present study, mean duration of hospital stay was 17.13 days. However, mean hospitalization time reported by Eftekharian et al. [8] was 7 days. Mean age of hospital stay was shorter for younger patients due to lack of associated co-morbid conditions and better function of their immune system.

Outcome

77.7% patients in the present study showed complete regression. Death occurred in two patients; one with associated chronic renal failure and septicemia with involvement of submandibular space and anterior visceral space; other having respiratory distress with diffuse swelling of left antero-lateral neck with parapharyngeal bulge was died suddenly due to seizure. One patient with malignancy of lateral pharyngeal wall showed progressive deterioration and discontinued the treatment.

Conclusion

DNIs are associated with severe complications which can be potentially fatal. Dental infection is the most common etiological factor and awareness of dental and oral hygiene should be done to prevent DNIs. Patients usually respond completely with timely intervention. More attention should be given to the patients associated with co-morbid conditions. Initial treatment should be started with I.V broad spectrum antibiotics and changed thereafter according to the culture and sensitivity report. Early surgical drainage should be done in cases of abscess formation.

Compliance with Ethical Standards

Conflict of interest None.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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