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Deep neck infections in children

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From December 1989 through 1998, a total of 68 children with deep neck infection were enrolled into this study. The mean age was 5.9 years (range, 1 month-15.8 years). Infections in the retropharyngeal space (36.7%) were most common, followed by parapharyngeal space (30.8%), peritonsillar space (20.6%), and submandibular space (11.9%). Fever, neck pain, and swelling were the most frequent symptoms. The most common pathogens were viridans streptococci (41%, 16/39) and *Staphylococcus aureus* (26%, 10/39). Other isolates included *Prevotella* spp., *Veillonella* spp., *Klebsiella pneumoniae*, *Escherichia coli*, *Morganella* spp., and *Enterobacter* spp. Mixed infection was found in 46% (18/39) of patients. The mean duration of hospitalization was 12.4 days (range, 2-45 days). Complete resolution was achieved in 61 (89.7%) children. Complications occurred in 7 patients, including recurrence, mediastinal spread, bacteremia, and suppurative thyroiditis; the patient with mediastinal spread plus bacteremia died. Five patients had congenital cyst and 4 of them had complications or recurrence/relapse. In conclusion, infections in the retropharyngeal space and polymicrobial infections were most common in deep neck infection of Taiwan children.

Key words: Children, deep neck infection, Taiwan

Delay in the diagnosis or inadequate or inappropriate treatment of deep neck infection (DNI) may lead to catastrophic complications such as mediastinitis, which has a high mortality rate of up to 40% [1]. Thorough knowledge of the important anatomic, etiologic, clinical factors, as well as diagnostic and therapeutic modalities is required for the proper management of deep neck space infection [2].

There have been few reports from Taiwan on the epidemiological features, clinical manifestations, and bacterial etiology of DNI in children [3,4]. This study investigated the clinical and bacteriological feature of DNI in Taiwan children.

Materials and Methods

Patient selection

From December 1989 through 1998, a total of 68 patients with a diagnosis of DNI treated at the Chang Gung Children's Hospital were enrolled into this study. The diagnosis of DNI was based on computed tomography (CT) (n = 26), surgical drainage (n = 15), or both (n = 27).

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Data collection

Antecedent illness, clinical presentation, physical examination, laboratory evaluation, and radiological findings of all patients were reviewed and analyzed. Antecedent illnesses and conditions included tonsillitis, viral upper respiratory infection, sinusitis, caries or stomatitis/gingivitis, blunt or penetrating trauma of the upper aerodigestive tract, and congenital cyst.

Preceding symptoms included fever, sore throat, dysphagia, odynophagia, loss of appetite, neck swelling or mass, neck pain, and limited neck motion. Physical examination included vital signs, neck mobility, and assessment for the presence of trismus, voice change, drooling, dyspnea or stridor, and cervical lymphadenopathy. Laboratory evaluation included white blood cell (WBC) count and C-reactive protein (CRP).

Plain-film radiography, ultrasonography, and neck CT were performed in all patients. All images were reviewed by a pediatric board-certified radiologist to determine the presence and location of the infectious process, which was classified as peritonsillar, retropharyngeal, parapharyngeal, submandibular, or combined. The lateral cervical films were interpreted by measuring the distance from the anterior aspect of the vertebral body to the air column of the posterior pharyngeal wall. If the distance was more than 1.5 times the width of the neighboring cervical vertebral body,

the retropharyngeal space was classified as widened. Chest radiography in the anterior-posterior view was arranged for the patients with any clinical presentation as chest pain, dysphagia, or septic shock. Mediastinal involvement was defined as a widened mediastinum on chest radiography and diffuse bulging of the mediastinal contours, with obliteration of the normal fat planes or a focal mass with ill-defined edges demonstrated on CT. Computed tomography findings suggestive of the diagnosis of DNI included early cellulitis or phlegmon, shown as hypodensity with either no ring or incomplete ring enhancement, and abscess with hypodensity and complete ring enhancement over the 4 potential spaces bounded by deep cervical fascia. The 4 potential spaces are peritonsillar, retropharyngeal, parapharyngeal, and submandibular space. The medial border of the peritonsillar space is the palatal tonsil, and is bounded laterally by the superior constrictor muscle. The retropharyngeal space lies behind the pharynx and esophagus, and extends superiorly to the base of the skull and inferiorly to the bifurcation of the trachea. The parapharyngeal space, which is next to the retropharyngeal space, extends to the base of skull. Its medial region extends to the lateral pharyngeal wall and is bounded laterally by the mandible, parotid glands, and internal pterygoid muscle. The submandibular space is bounded by a superficial layer of deep cervical fascia inferiorly and by lingual mucosa superiorly. The diagnosis of DNI was confirmed by surgical drainage of pus from these potential spaces.

The bacteriologic data were obtained from clinical laboratory records. Data for outcome assessment including duration of hospital stay, condition of patients at time of discharge, and complications were recorded from medical charts. Recurrence was defined as return of the disease after a complete remission for at least 6 months. Relapse was defined as DNI recurrence within 1 month after treatment.

Statistics

Chi-square test was used to analyze the categorical variables including sex, symptoms, preceding disease, radiological findings, treatment, and complications. Analysis of variance was used to study continuous variables including age, duration of preceding symptoms before admission, duration of hospital stay, WBC, and CRP. A p value less than 0.05 was considered statistically significant.

Results

Demographic and clinical characteristics

During the 10-year study period, 68 children with deep neck space infection were diagnosed and treated, including 39 (57%) boys and 29 (43%) girls. The mean age was 5.9 ± 4.4 years, ranged from 24 days to 16 years (Table 1).

The most common site of infection was the retropharyngeal space (37%, 25/68), followed by the parapharyngeal (31%, 21/68), peritonsillar (21%, 14/68), and submandibular (12%, 8/68) space. Eight (12%) children had infections in more than one fascial space. Four (6%) children had both peritonsillar and parapharyngeal infection, and the other 4 (6%) had both retropharyngeal and parapharyngeal infection (Table 1).

Associated preceding illness

The associated preceding illnesses of the patients are shown in Table 2. The most common known associated factors were preceding viral upper respiratory infection (16.2%) and penetrating or blunt trauma of the upper aerodigestive tract (10.3%). Trauma of the upper aerodigestive tract was the significantly associated predisposing factor for retropharyngeal DNI compared with other DNI ($\chi^2 = 5.9$, p=0.015). Underlying congenital cysts were found in 5 (7.4%) patients.

Clinical presentation

The presenting symptoms and signs of the 68 patients are shown in Table 3. The most common symptoms at presentation were fever (63%) and neck pain (47.1%). The mean duration of symptoms before admission was 5.9 days (range, 1-14 days). Forty-three (63%) children had fever on admission. In patients with retropharyn-

Table 1. Demographic characteristic of 68 children with deep neck infections

	Anatomic site				Total n = 68
	Peritonsillar n = 14	Retropharyngeal n = 25	Parapharyngeal n = 21	Submandibular n = 8	
Age, year[a]	8.7 ± 4.3	4.9 ± 3.2	5.5 ± 4.5	5.5 ± 5.6	5.9 ± 4.4
Sex					
Male (%)	10 (71.4)	12 (48)	12 (57.1)	5	39 (57.4)
Female (%)	4 (28.6)	13 (52)	9 (42.9)	3	29 (42.6)

[a]Data are presented as mean ± standard deviation.

Table 2. Antecedent illness and site of deep neck infection in 68 children

	Peritonsillar n = 14 (%)	Retropharyngeal n = 25 (%)	Parapharyngeal n = 21 (%)	Submandibular n = 8	Total n = 68 (%)
Tonsillitis	1 (14.3)	1 (4)	0	0	2 (2.9)
Upper respiratory tract infection	3 (21.4)	4 (16)	4 (19.1)	0	11 (16.2)
Sinusitis	1 (14.3)	2 (8)	1 (4.8)	0	4 (5.9)
Dental infection	0	0	0	2	2 (2.9)
Trauma	0	6 (24)	1 (4.8)	0	7 (10.3)
Congenital cyst	0	0	4 (19)	1	5 (7.4)
Unknown	9 (64.3)	12 (48)	11 (52.4)	5	37 (54.4)

geal space infection, the mean duration of fever before admission was only 2.4 days, which was the shortest among these 4 groups (p=0.003). All cases with mediastinal spread in this series occurred in retropharyngeal space infections ($\chi^2 = 4.7$; p=0.03); retropharyngeal space infections thus seemed to have more rapid onset and potential for mediastinal spread.

The most common physical findings on admission were swelling of the neck or neck mass (61.8%), and pain or stiffness during passive movement of the neck (13.2%).

Laboratory findings

Leukocytosis (WBC, >15 000 /mm^3) was found in 37 (58.7%) patients. The mean WBC count on admission was 17 572 /mm^3 (range, 2600-44 300 /mm^3). Forty-one (89.1%) patients had elevated CRP (>5 mg/L) with a mean value of 88 mg/L and a range of 3.3 to 319 mg/L.

Widening of the retropharyngeal or prevertebral spaces on lateral neck radiographs was found in 79% (11/14) of patients with retropharyngeal infections and 29% (6/21) of patients with parapharyngeal infections. Review of the CT scans of 53 children revealed abscess with a homogenous area of hypolucency and ring enhancement in 36 (67.9%) cases, and early abscess or phlegmon with focal hypolucency mass without ring enhancement in 17 (32.19%) cases.

A pus sample was obtained from 41 children, and a total of 56 microorganisms were isolated on pus culture

Table 3. Initial symptoms, signs, and duration of hospitalization in 68 children with deep neck infection

Symptom/sign	Peritonsillar n = 14 (%)	Retropharyngeal n = 25 (%)	Parapharyngeal n = 21 (%)	Submandibular n = 8	Total n = 68 (%)
Fever	9 (64.3)	13 (52)	12 (57.1)	5	43 (63)
Duration, day[a]	3.8	2.4	4.6	3.5	3.3
Duration of symptom, day[b]	5.3	5.0	8.7	2.6	5.9
Sore throat	11 (78.6)	5 (20)	4 (19.1)	0	20 (29.4)
Dysphagia	3 (21.4)	5 (20)	4 (19.1)	3	14 (20.6)
Odynophagia	6 (42.8)	5 (20)	2 (9.5)	0	13 (19.1)
Trismus	1 (7.1)	3 (12)	2 (9.5)	2	8 (11.8)
Toothache	0	1 (4)	1 (4.8)	3	4 (5.9)
Neck pain	5 (35.7)	13 (52)	11 (52.3)	6	32 (47.1)
Neck swelling	5	17 (68)	13 (61.9)	5	42 (61.8)
Hoarseness	0	2 (8)	0	1	3 (4.4)
Dyspnea	0	4 (16)	1 (4.8)	1	7 (10.3)
Limited neck motion	0	6 (24)	0	1	9 (13.2)
Decreased appetite	1 (7.1)	6 (24)	6 (28.6)	1	14 (20.6)
Irritability	1 (7.1)	1 (4)	2 (9.5)	1	5 (7.4)
Duration of hospitalization, day[c]					
Mean ± SD	7.2 ± 2.8	13.2 ± 10.2	11.7 ± 4.3	12.4 ± 2.8	9.1 ± 4
Range	5-14	2-45	5-23	2-45	3-14

[a] p=0.003.
[b] p=0.0353.
[c] p=0.004.

in 39 of these children. Forty-six percent (18/39) had mixed bacterial species. The most frequent aerobic organism isolates was *Streptococcus* spp. (41%, 16/39), with susceptibility to penicillin in 62.5% (10/16) of isolates, followed by *Staphylococcus aureus* (25.6%, 10/39), of which 90% (9/10) of isolates were oxacillin-susceptible. The most common anaerobic organisms were *Prevotella* spp. (12.8%, 5/39) and *Veillonella* spp. (10.3%, 4/39). The isolated infecting organisms are shown in Table 4. Cultures failed to reveal any pathogen in 2 patients.

Treatment and outcome

All patients received parenteral antibiotics after admission. Twenty (29.4%) children recovered from the infection with only conservative medical management. They included 4 patients with peritonsillar space infection, 10 with retropharyngeal space infection, 4 with parapharyngeal space infection, and 2 with submandibular space infection. Forty-eight of the 68 patients received surgical drainage, of whom 4 had mediastinal spread and underwent mediastinotomy.

There were 7 patients with complications, recurrence, or relapse. Among the 4 patients with mediastinal spread, 3 had retropharyngeal space infections with one extended to parapharyngeal space infection; one of these patients developed also bacteremia and died. Another 2 patients with the complication of suppurative thyroiditis were identified to have underlying congenital cyst. Two patients had recurrence; one of them had esophageal trauma with mediastinal spread and the other had branchial cyst. Three patients with relapse within 1 month of discharge have received inadequate therapy for congenital cyst or extensive mediastinal involvement. A total of 2 cases were mentally retarded and 5 had underlying congenital cysts, 4 of whom had complications or recurrence/relapse. The mean duration of hospital stay was 12.4 days (range, 2-45 days).

Discussion

The purpose of this study was to determine the presentation, bacteriology, and outcome of DNI in Taiwan children. Deep neck infections have a unique clinical presentation including pain on neck motion or limited range of neck motion, fever, neck mass or swelling, dysphagia, or anorexia [5]. A variety of causes have been associated with DNI, including prior upper respiratory infection (pharyngitis, tonsillitis, sinusitis), dental infection or manipulation, and trauma to the upper aerodigestive tract. However, like previous series, many patients in this series did not report any precipitating event [6].

In this series, the finding that retropharyngeal infection was the most common type of DNI is rather different from previous studies, which found peritonsillar infection to be the most common type [7,8]. This may be related to the lower mean age of patients in this series (5.96 years) compared with previous studies (7.8 years). Anyhow, the mean age of the patients with retropharyngeal space infections in this series was 4.93 years, which is similar to a previous

Table 4. Microbiology in 41 children with deep neck infection

	Peritonsillar n = 10	Retropharyngeal n = 7	Parapharyngeal n = 18	Submandibular n = 6	Total n = 41
Aerobic					
Viridans streptococci	3	8	4	1	16
GAS	1	0	0	0	1
GBS	0	1	2	0	3
Staphylococcus aureus	0	2	5	3	10
Staphylococcus epidermitis	0	0	0	1	1
Klebsiella oxytoca	3	0	0	0	3
Klebsiella pneumoniae	0	3	1	0	4
Pseudomonas aeruginosa	1	1	0	0	2
Capnocytophaga	0	0	1	0	1
Escherichia coli	0	1	3	0	4
Enterobacter sp.	0	0	1	0	1
Morganella morganii	1	0	0	0	1
Anaerobic					
Veillonella alcalescens	1	2	1	0	4
Prevotella spp.	1	2	2	0	5
Mixed	3	7	6	2	18
No growth	0	0	1	1	2

Abbreviations: GAS = group A *Streptococcus*; GBS = group B *Streptococcus*

series [7]. Dodds and Maniglia [8] found that limited neck motion and torticollis were common important signs of retropharyngeal infection. In this study, these symptoms were found in 24% of patient with retropharyngeal space infection, whereas 68% of these patients complained of neck swelling. Furthermore, trauma of the aerodigestive tract tended to cause more retropharyngeal infections than other types of DNI ($\chi^2 = 5.9$; p=0.015).

Apart from retropharyngeal space infection, parapharyngeal space infection was the next common area of DNI in this study. Precipitating factors for parapharyngeal space infection included extension of infection from a peritonsillar abscess, retropharyngeal abscess, and infection of congenital branchial cysts or sinuses [9]. Swelling of neck with pain was the most common complaint in this series, similar to that reported previously [10].

Peritonsillar space infection, which is most common in older children, was the third most frequent type of DNI in this study. Although the patients included in this study had either a pus sample obtained after incision and drainage or signs of the infection on CT, most of the peritonsillar infections were diagnosed based on clinical symptoms of sore throat, odynophagia, and tonsillar bulging, and the patients responded well to conservative treatment at local hospitals. The mean age of this group was 8.75 years, which was 3 years younger than that in other studies (12.2 years and 12.6 years) [11,12]. Sorethroat and odynophagia were the most common complaints in this series.

The diagnosis of deep neck abscess can generally be made based on a thorough medical history and the findings of physical examination. Diagnostic imaging, nevertheless, can help localizing the abscess. Lateral radiographs of the neck have been used for the diagnosis of retropharyngeal abscesses, on the basis of the characteristic prevertebral soft tissue swelling, loss of cervical lordotic curvature, or presence of air in the soft tissue [13-16]. In this study, only 78% (11/14) of patients with retropharyngeal abscesses had positive radiological findings. The absence of radiologic evidence in some of the patients may have been resulted from the normal variations in the soft tissues of the neck in children with different phases of respiration, crying, and swallowing, and in various degrees of neck flexion or extension. In addition, the prevertebral thickening may be present not only in the retropharyngeal infection, but also in some of the parapharyngeal infection (1/11, 9%). This finding is in agreement with previous studies, which reported that lateral neck radiographs have a sensitivity of 83% for determining the presence of a pediatric DNI [17], whereas CT scanning with contrast had a sensitivity of ranging 87.6% to 100% [18,19]. Compared with radiography, CT provides an easier evaluation and interpretation in the face of normal variations, a more accurate localization of the inflammatory process, and a more accurate determination of the extent of the disease as well as the position of the great vessels in DNIs [20].

Antimicrobial therapy of DNIs is directed against the usual offending pathogens. These infections are often polymicrobial or mixed with a combination of aerobic and anaerobic flora [21-24]. The most common aerobic isolates in this study were viridans streptococci (41%, 16/39) and *S. aureus* (26%, 10/39), group B and group A *Streptococcus* (13%, 5/39), and *Klebsiella* species (10%, 4/39). The predominant anaerobes included *Prevotella* species (10%, 4/39) and *Veillonella* species (13%, 5/39). Mixed infection was found in 46% (18/39) of patients. Penicillin has been used frequently to treat these infections because of the susceptibility of most of the pathogens to this agent. It is now recognized, however, that DNIs caused by β-lactamase-producing organisms are less unusual, as shown in the study by Brook *et al* [22]. All patients in this study received penicillin or a penicillin derivative, clindamycin, a β-lactam/β-lactamase inhibitor combination, or a cephalosporin.

The role of surgical drainage in the management of DNI is controversial. Some studies have indicated that operative drainage should be the standard treatment for any abscess of the deep neck spaces; antibiotics alone can cure only 10% to 15% of patients and thus cannot replace surgery [25-28]. Broughon *et al* [28] found a higher percentage of patients (50%) who responded well to medical treatment. In this study, 20 (29.4%) children recovered from DNI with medical treatment and did not require surgical drainage.

Complications of DNI most commonly result from a delay in diagnosis and extension beyond the primary space involved. Within the interconnected network of the fascia lie major neurovascular structures. The spread of infection to these adjacent neurovascular structures may result in carotid artery erosion, internal jugular thrombosis, and neurologic deficits such as Horner syndrome. Further delay in treatment may result in local complications such as osteomyelitis or spread of infection beyond the neck to cause severe conditions, such as sepsis and mediastinitis. For diagnosis of mediastinitis, a chest radiograph should be obtained to rule out a widened mediastinum, pneumothorax, and pneumomediastinum. Estera *et al* [1] found a 42.8% mortality rate in complicated cases with descending

necrotizing mediastinitis. In this study, complications occurred more frequently in the retropharyngeal space infection (50%) than in other types of DNI, and the patients with underlying congenital cyst and mental retardation also tended to have complications.

In conclusion, the clinical manifestations of DNI in children in Taiwan are similar to those reported in other populations. Most cases of DNI are curable and recurrence is rare. However, a recurrence of a DNI should alert physicians to some underlying anomaly.

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