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Early surgical intervention enhances recovery of severe pediatric deep neck infection patients

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ABSTRACT

Purpose: Pediatric deep neck space infection (DNI) is a relatively rare but potentially life-threatening condition and requires prompt and accurate management. This study retrospectively reviews our experience in a tertiary referral hospital from 2004 to 2019.
Methods: Systematic data collection from medical records using ICD10 codes between 2004 and 2019.
Inclusion criteria: age ≤16 years, DNI requiring hospitalization and/or surgery.
Exclusion: peritonsillar abscess without complications.
Results: We identified 42 patients, 21 boys and 21 girls, with a median age of 4.9 years. Most of the patients had severe symptoms, the most common of which were neck swelling (n = 39; 92.9%), neck pain (n = 39; 92.9%) and fever (n = 32; 76.2%). Twenty-two (52.4%) had torticollis, and the mean duration of symptoms before hospitalization was 4.95 days. Diagnosis was confirmed by MRI (n = 24), contrast-enhanced CT (n = 11) or ultrasonography (n = 6), except in one case. Twenty-three (54.8%) required an open neck incision, ten (23.8%) patients had intraoral surgery and nine were treated conservatively. Twelve (28.6%) patients were admitted to the pediatric ICU. Median hospitalization duration was six days. The infection most commonly had tonsillopharyngeal etiology (n = 18) and a retropharyngeal location (n = 17). *Staphylococcus Aureus* (n = 7) and *Streptococcus pyogenes* (n = 7) were the most frequent pathogens. We compared the early surgical intervention group (<2 days of intravenous antibiotics; n = 18; 42.9%) to the late surgery group (n = 15; 35.7%) and the conservatively treated groups (n = 9; 21.4%). The overall length of stay (LOS) was lower in the shorter preoperative medication group (mean 4.4 vs. 7.2; $p = 0.009$). The size of the abscess did not differ between the groups (mean 28 mm; 30 mm; 21 mm; $p = 0.075$) and the neck incision rate was similar in the operated groups.
Conclusion: Early surgical intervention is associated with decreased LOS among severe pediatric DNI patients.

1. Introduction

Acute deep neck infections (DNI) are relatively rare among children but still cause significant morbidity and complications that can be life-threatening. Retropharyngeal and parapharyngeal abscesses are common manifestations of the disease. Airway compromise, mediastinitis, sepsis, internal jugular vein thrombosis and carotid artery aneurysm or rupture have been described [1–3]. Clinical features often include neck pain and swelling, fever, dysphagia, odynophagia, torticollis and trismus [3–6]. Several reports have proposed that incidence is increasing [7–9].

Broad spectrum intravenous antibiotic treatment, often combined with incision and drainage, has been considered the mainstay of the treatment of pediatric DNIs. Nevertheless, many recent studies have reported successful non-operative management in selected cases, which has led to questioning the need for immediate incision and drainage of abscesses [2,10–13]. Younger age, compromised airway and/or an abscess affecting multiple spaces, as well as the abscess being >22–25 mm in size are considered reasons for considering direct surgical intervention [2,4,12,14]. Yet, the optimal timing of surgical intervention has not been completely established.

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Our objective was to describe the clinical presentation and to investigate whether the outcome of early surgical intervention (<2 days intravenous antibiotics beforehand) differs from that among those who are operated on later in the course of the disease. We included a conservatively treated group in the analysis to obtain a relevant evaluation.

2. Materials and methods

The study design was a retrospective review conducted in a tertiary referral hospital. Data from 1.1.2004 to 31.12.2015 was partly included in a previous publication, which consisted of both adults and pediatric surgically treated patients [15]. Due to a limited number of pediatric cases, we extended our data search to 30.9.2019 and included patients aged ≤16 diagnosed with a DNI requiring hospitalization and conservative or surgical treatment, including intraoral and cervical openings. DNI diagnosis was defined as a delineated abscess in the deep neck spaces or a significant phlegmon in imaging, combined with severe clinical symptoms. Patients diagnosed with a peritonsillar abscess without any complications were excluded.

Systematic data collection was used to identify etiology and variable risk factors. We searched for patients for this study in electronical medical records, using ICD10 codes (J39.0, J39.1, L02.1, K12.2) and confirmed them with operational codes (Nordic Classification of Surgical Procedures), including ENA32, ENA00, EDA00. We then systematically selected those who met the criteria. We searched for conservatively treated patients by combining imaging results with ICD10 codes. We reviewed clinical status, etiology, associated systemic diseases, airway status, treatment, re-operations, duration of hospitalization, ICU days, bacterial cultures, complications and outcomes of DNIs. DNI diagnosis was usually confirmed by a magnetic resonance imaging (MRI) examination, contrast enhanced computer tomography (ce-CT) or an ultrasonography. We also analyzed the localization and spaces involved.

IBM SPSS Statistics version 25 was used for the analysis. We performed *Fisher's exact* test (2-sided significance) when dealing with an expected group size of under five to compare the categorical data of the groups with an asymptotic two-sided significance, a p value of <0.05 being considered significant. Due to the sample size being <30, we applied the *Kruskal-Wallis* test for independent samples to compare the continuous variables of the three groups, and the *Mann-Whitney U* test to compare the two groups. A two-sided p value of <0.05 was considered statistically significant.

3. Results

In total, 42 patients met the criteria. The number of males (n = 21) and females (n = 21) in the cohort was equal. The number of patients in each age group by gender is shown in Fig. 1. The age distribution was between six months and 16 years (mean 6.85; SD 5.49). Two patients had significant comorbidities, one had received oncological treatment (radiation therapy to the head and neck region) during early childhood, and another had immunosuppressive medication for juvenile rheumatoid arthritis.

3.1. Clinical features

The duration of the symptoms before hospitalization varied between 1 and 14 days (mean 4.95; SD 3.19). Most of the patients had severe symptoms. The most common presenting symptoms were neck swelling (n = 39; 92.9%), neck pain (n = 39; 92.9%) and fever (n = 32; 76.2%). Twenty-two patients (52.4%) had torticollis. The main complaints and findings are specified in Fig. 2. A bulging lateral wall of the pharynx (p = 0.042) and trismus (p = 0.026) were a significantly more common finding in the subgroup (Group 1) of patients who were treated with intravenous antibiotics for less than two days before surgery than in the conservatively managed group (Group 3). Other symptoms and status findings of the groups did not differ. A tonsillopharyngeal origin was the most common (n = 18; 42.9%). Lymphadenitis was considered the cause of the infection in nine (21.4%) and a dental focus in two (4.8%) of the cases. The etiology remained unknown in ten (23.8%) cases. Fig. 3 shows the specific distribution of the etiology. Other causes (n = 3) found were otitis, sinusitis and branchial cysts, which were considered to be origin of the suppurative neck infection. The fascial spaces involved are listed in Table 1. Retropharyngeal location was the most common for the infection (n = 17; 40.5%). Parapharyngeal (n = 12; 28.6%) and submandibular (n = 3; 7.1%) spaces were the other frequently involved loci.

3.2. Diagnosis and treatment

MRI confirmed DNI in 24 (57.1%), a ce-CT in 9 (26.2%) and an ultrasonography in 6 (14.3%) cases. Fig. 4a and b demonstrate a clear delineation of an abscess in the retropharyngeal region on the MRI. One patient (2.4%) did not undergo preoperative imaging. A lateral neck X-ray was not utilized on this indication. Table 2 shows the imaging findings and their correlation with the surgical findings. The mean of the delay between admission and the CT or MRI examination was 1.26 days

Figure 1. Age and gender distribution

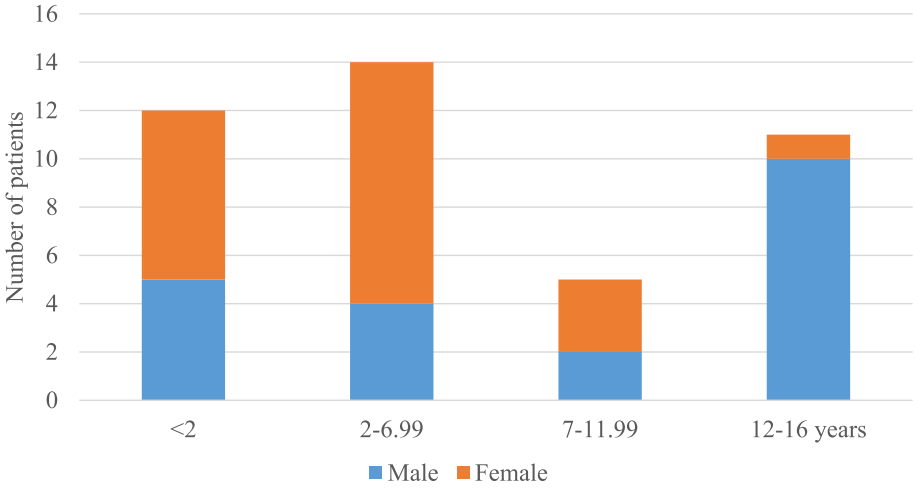

Fig. 1. Age and gender distribution.

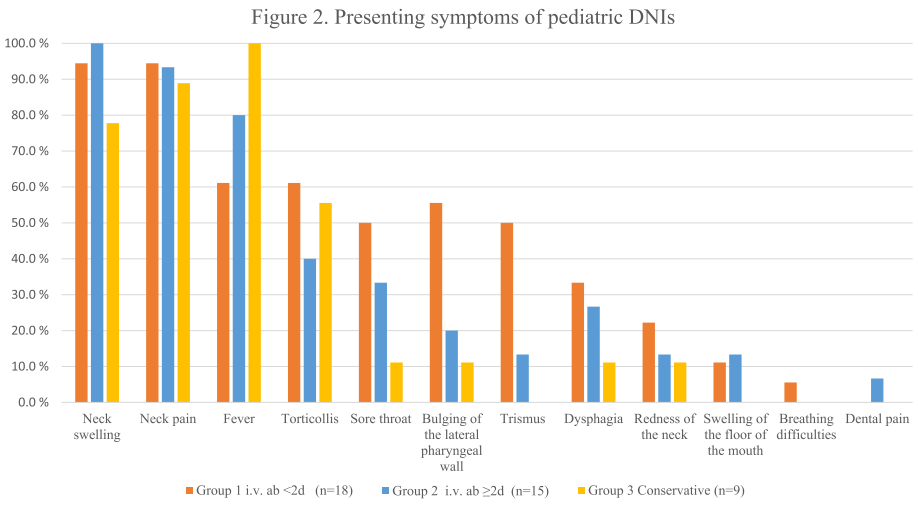

Fig. 2. Presenting symptoms of pediatric DNIs.

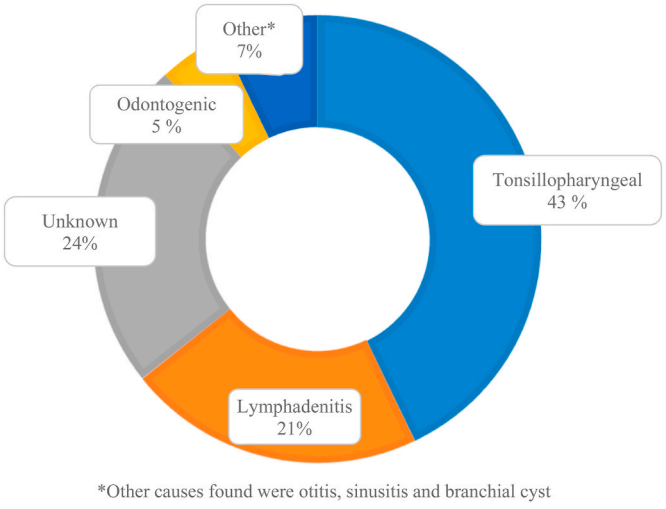

Fig. 3. Etiology of pediatric deep neck infections.

Table 1
Main neck spaces involved.

Space	No. cases	%
Retropharyngeal	17	40.5
Parapharyngeal	12	28.6
Submandibular	3	7.1
Carotid space	2	4.8
Submental	2	4.8
Pretracheal	2	4.8
Sublingual	1	2.4
Multifocal	1	2.4
Unknown	2	4.8

(range 0–6; SD 1.65). Fifty-two percent of the patients (n = 22) required anesthesia for imaging, and repeated imaging (with CT or MRI) was necessary in eight (19.0%) cases. Notably, the delayed surgery group (Group 2) had three cases of repeated imaging to control the state of infection, and the conservative group (Group 3) had four. One case in Group 1 required MRI after ce-CT for more accurate preoperative information. The delay between admission and imaging (MRI/CT) was significantly longer when anesthesia was needed ($p = 0.007$). Moreover, patients treated with intravenous antibiotics two or more days before the surgery (Group 2) had a longer delay (mean 2.33d; SD 1.61) before imaging ($p = 0.002$) than those in the other groups. We found six patients who had ultrasound as first line imaging before MRI, and these were all in the delayed surgery group. In four out of these six cases, the ultrasound was unable to show an abscess, nevertheless MRI one to three days later confirmed DNI. We also compared the surgical confirmation of an abscess to the imaging reports. A false positive abscess finding (no pus found during surgery) was noted in two (12%) MRI scan cases and in one (11%) ce-CT case ($p = 1.00$). The size of the abscess was mentioned in the radiology report in most cases, but if missing, it was measured directly from the original scans using the maximum dimension of the abscess. The mean size of the abscesses was 27.6 mm, varying between 9 and 56 mm (SD 10.7 mm).

All the patients received intravenous antibiotics initially at admission. Cefuroxime combined with metronidazole (n = 15; 35.7%) was most often used for empiric antimicrobial treatment, although cefuroxime alone (n = 11; 26.2%) and cefuroxime with clindamycin (n = 6; 14.3%) were also frequently utilized. Antimicrobial therapy was later specified according to the microbiological findings and the drug sensitivity tests. Thirteen patients (31.0%) received pre-hospitalization oral antibiotics. Fifteen (35.7%) patients were treated with intravenous antibiotics two or more days (mean 3.53; median 2.0; SD 2.23) before surgery. Most of the patients came directly or on the same day to an ENT consultation (n = 25; 61.0%). The mean delay from admission to the ENT consultation was 0.76 days (range 0–6; SD 1.30). The necessity and timing of the surgical intervention was individually considered on the basis of clinical and the radiological investigations. Mean C-reactive protein (CRP) was 106 mg/L (range 4–380; SD 82.5) and the median was 85 mg/L at admission. The mean white blood cell count (WBC) was 19.4 E9/L (range 7.5–36.8; SD 7.57) and the median was 18.7 E9/L. CRP ($p = 0.360$), or the white blood cell count of the groups did not differ ($p = 0.631$).

Twelve (28.6%) patients were admitted to the pediatric intensive care unit (PICU). The mean of PICU stays was 4.3 days (range 1–17, SD 5.58) and the median 2.0 days. The mean overall length of stay (LOS) was 6.45 days (range 2–24. SD 4.36) and the median 6.0 days. Younger children, aged <7 years (n = 26), needed PICU treatment more often (n = 10; 38.5%; $p = 0.090$) than older ones (n = 2; 12.5%). Twenty-three (69.7%) required a cervical incision and an intraoral incision was necessary for ten (30.3%) patients in the surgically treated groups (Group 1, 2). The presence of pus intraoperatively was mentioned in 30 (90.9%) of the cases, cellulitis was described twice and the finding was uncertain in one case. Tonsillectomy was performed on seven patients and adenotomy/adenotonsillectomy on two. Dental extraction (n = 2) was necessary in cases that required managing odontogenic foci.

The total complication rate was 14.3% (n = 6). One patient required

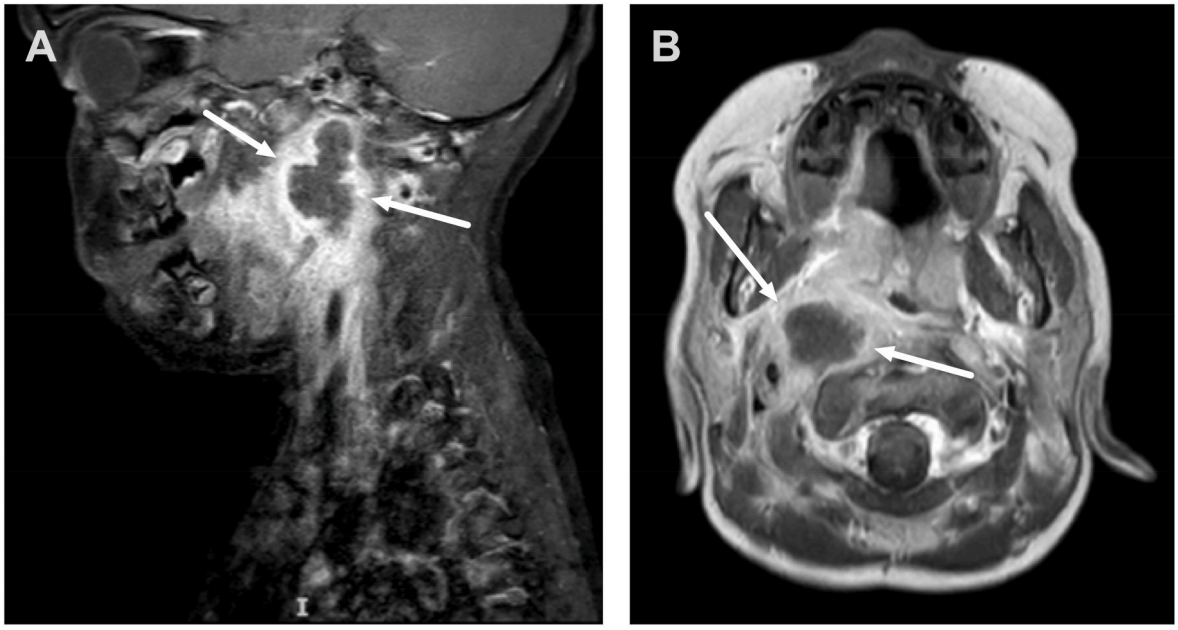

Fig. 4. A retropharyngeal abscess in a 4-year-old boy. Sagittal (A) and axial (B) gadolinium-enhanced T1-weighted MR images demonstrate a large (about 2 x 2.5 × 4 cm), ring-enhancing lesion with a non-enhancing center in the retropharyngeal space, consistent with an abscess. This abscess was located medial to great vessels, and was thus successfully incised and drained intraorally after tonsillectomy.

Table 2
Imaging findings and surgically confirmed accuracy.

	No. cases	%	Abscess reported in scan (n)	%	Ring-enhancement reported (n)	%	Evidence of pus at surgery (n)	%
MRI	17	51.5	17	100	14	82.4	15	88.2
ce-CT	9	27.3	9	100	7	77.8	8	88.9

a re-incision and drainage two days after the primary neck incision, but the others had complete resolution after initial surgery. Two patients in surgically treated subgroups (Group 1,2) had other complications; one pneumonia from aspiration and one 10-month-old had *Rothia mucilaginosa* sepsis. The conservative treatment group had two critically ill patients. One nine-month-old patient had already suffered from severe streptococcal sepsis six days before a small fluid collection in the retropharyngeal area was detected, and later also developed mediastinitis and required a thoracoscopy and pleural drainage to control the disease. One 15-year-old had a parapharyngeal abscess (23 mm), *Fucobacterium necrophorum* sepsis and Lemierre's syndrome (internal jugular vein thrombosis) complicated by disseminated intravascular coagulation and thrombocytopenia at presentation, and surgery was considered contraindicated. According to patient records, quick resolution of the abscesses in the head and neck area led to conservative management in these otherwise complicated cases. All patients were released from hospital without sequelae, the median follow-up time was 44 days (range 3–695; SD 135.6). No neural or vascular complications were detected.

3.3. Microbiology

Bacterial culture results were available in 30 cases. Table 3 shows the microbiology of the deep neck abscesses. *Staphylococcus aureus* (n = 7; 23.3%), *Streptococcus pyogenes* (n = 7; 23.3%) and a negative culture (n = 8; 26.7%) were most frequently encountered. Prevotella species and *Eikenella corrodens* are anaerobic bacteria found in human oral flora, as is the fusobacterium species. Methicillin-resistant *Staphylococcus aureus* was found in one case. We isolated *Streptococcus pyogenes, Fucobacterium necrophorum* and *Rothia mucilaginosa* from the blood cultures. In addition, in the conservatively managed group, we found two *Streptococcus pyogenes* in throat swap samples, one from a maxillary sinus lavation sample and *Haemophilus influenzae* from a middle ear fluid sample taken during tympanostomy.

Table 3
Organisms found in bacterial cultures of pediatric deep neck infections.

Bacterial cultures	No. culture findings	%[a]
Staphylococcus aureus	7	23.3
Streptococcus pyogenes	7	23.3
Mixed flora	4	13.3
Viridans group streptococci	3	10.0
Prevotella species	3	10.0
Eikenella corrodens	1	3.3
Fusobacterium necrophorum	1	3.3
MRSA (methicillin-resistant Staphylococcus Aureus)	1	3.3
Propionibacterium acnes	1	3.3
Negative culture	8	26.7

[a] The percentage of samples available (n = 30) exceeds 100% due to the multi bacterial growth in 3 (10.0%) cases.

3.4. Timing of the operation

In order to evaluate the timing of the operation, we divided the patients into three subgroups. We compared the patients receiving intravenous antibiotics less than two (<2) days (n = 18; 42.9%) before the surgical intervention (Group 1) to those who had a longer time (Group 2; n = 15; 35.7%) and to those who were treated only conservatively (Group 3; n = 9; 21.4%). Due to its retrospective nature, this method enabled us to harmonize the onset of the medical treatment period, but we have to take into account the fact that these empirical parenteral antibiotics might have been initiated before an exact diagnosis. Table 4 presents the results. The size of the abscess in the groups did not differ

Table 4
Outcomes of the pediatric deep neck space infections.

Variable	Group 1 i.v. ab <2d (n = 18)	Group 2 i.v. ab ≥2d (n = 15)	Group 3 conservative (n = 9)	p value
Pediatric ICU admission	4 (22.2%)	6 (40.0%)	2 (22.2%)	0.611[a]
Mean overall length of stay (median) days	4.4 (4.0)	7.2 (7.0)	9.2 (6.0)	0.009[b]
Mean size of the abscess (median) mm	28 (26)	30 (30)	21 (19)	0.075[b]
Neck incision rate (%)	12 (66.7%)	11 (73.3%)	–	0.722[a]
Complication rate (%)	1 (5.2%)[c]	2 (13.3%)[d]	3 (33.3%)[e]	0.154[a]

The significant *p* value is shown in bold.
[a] Fisher's exact test.
[b] Kruskal-Wallis test: significant difference in overall length of stay between groups 1 and 2 in pairwise comparisons (Bonferroni-adjusted $p = 0.009$).
[c] One sepsis.
[d] Pneumonia and re-incision.
[e] Lemierre sdr, mediastinitis, clival osteomyelitis.

statistically ($p = 0.075$) and the neck incision rate (66.7% vs. 73.3%; $p = 0.722$) was similar in the operated groups. The slight difference in the complication rates did not reach statistical significance ($p = 0.154$). Overall hospitalization was shorter in the shorter preoperative i.v. group (Group 1) (mean 4.4 vs. 7.2; $p = 0.009$) than in the delayed surgically treated group (Group 2). No significant difference was noted between the conservative and the surgical groups (G1/G3; $p = 0.153$; G2/G3 $p = 1.000$). Furthermore, there was a slight increased need for PICU treatment (n = 6 vs. n = 4) in the longer preoperative medical treatment group, but this did not reach statistical significance ($p = 0.611$). The mean age in the operated groups varied significantly, being 9.6 years (SD 5.53; range 0.9–16.0) in the group receiving i.v. antibiotics for <2d (Group 1) and 3.6 years (SD 3.55; range 0.5–14.0) in the group (Group 2) receiving i.v. antibiotics for ≥2 days ($p = 0.004$), but did not vary in comparison to the conservative group mean of 6.9 years (SD 5.48; range 0.8–15.0): Group 1 vs. Group 3 was $p = 0.604$; Group 2 vs. Group 3 was $p = 0.463$.

4. Discussion

Above we have presented our study of 42 pediatric deep neck infections. Our aim was to describe the clinical presentation and to investigate whether the outcome differed depending on the timing of surgical intervention and conservative treatment. Neck swelling and pain can be considered clear symptoms that indicate an evolving emergency. The other complaints we found (Fig. 2.) were mainly unspecific and overlapped with a common upper respiratory tract infection. The correct diagnosis and treatment of pediatric DNIs require a high level of suspicion and prompt management strategies. Intravenous antibiotic treatment, monitoring and securing the airway when necessary, and consideration of the need for surgery is the mainstay of treatment [2,10–14]. Our results show that delayed surgery was associated with a longer LOS. Similar trends were reported by Cheng et al. (2013) (increased median LOS by two days) and Page et al. (2008), the latter regarding only retropharyngeal infections. However, the differences did not reach statistical significance [2,16].

An association between delayed drainage and morbidity and mortality has been shown among adults, but according to Cramer et al. (2016), this was not the case in a pediatric group [17]. They also showed that >3 days delay in surgery significantly increased LOS in both groups. Our results regarding relatively large abscesses (mean size 27.6 mm) that cause severe symptoms suggest that even a shorter delay (≥2d) can increase LOS.

The most common complaints included neck swelling and pain, fever, torticollis and sore throat. These findings are in concordance with many previous reports of symptoms [5,8,16,18]. Nevertheless, considering the higher percentage of neck symptoms (swelling 92.9%, pain 92.9% and torticollis 52.4%), we hypothesize that these signs are overexpressed in this mainly surgically treated population. Meyer et al. (2009) reported neck swelling among 28.2% and pain among 48.0% of study participants, and Grisaru-Soen et al. (2010) [6,13] reported responding figures of 46% and 61%. In our present evaluation, a bulging of the lateral pharyngeal wall and trismus were more common in the early surgery group (Group 1). This is plausible, considering the potential for a narrowed airway in these cases. Retropharyngeal and parapharyngeal locations were typical, as in prior publications [2,3,6,10,12]. This finding differs from those among adults and it has been assumed that the presence of a retropharyngeal chain of lymph nodes is a potential source of the infection among younger children in particular [13]. The most common etiologies were tonsillopharyngeal (43%) and suppurative lymphadenitis (21%). The cause remained unknown in 24% of the cases, as odontogenic origin (5%) was rare. Moreover, oropharyngeal infection has been the main origin in several previous studies on pediatric DNIs [3,4,6]. Among adults, on the other hand, odontogenic infections have shown to be a major cause of morbidity [15]. Previous pediatric studies show that complicated dental infections do occur, especially in cases of submandibular abscess [4,19]. Identification of a possible dental cause should be included (orthopantomography) in the work-up of these cases, as early dental extraction would enhance recovery [15].

Empiric antibiotic therapy was usually initiated by a pediatrician at admission to pediatric inpatient care. The timing of the primary imaging varied (mean 1.26 days from admission), which could have promoted delay in some cases. In our study, the mean abscess size in surgery groups was 29.3 mm (SD 10.8 mm), which can be considered a reason to favor surgical intervention, which is in concordance with the chosen intervention. Because of the long time period (2004–2019) in this retrospective review, we had no constant treatment protocol. The timing of the operation may have also been affected by the possible delay of the ENT consultation (mean 0.76 days) and by the on-call surgeon's preferences. Nevertheless, the lack of clinical improvement despite intravenous antibiotics or a worsening condition in delayed cases were usually considered to require prompt surgical intervention.

In the delayed surgery group the mean age was lower. This finding is partly contrary to the currently reported factors for surgical intervention. The age of <4 years could be considered a preference for primary surgical intervention [11]. We found that the delay between admission and imaging (MRI/CT) increased when anesthesia was required for the examination ($p = 0.007$). This may also have contributed to raising the imaging threshold among younger children. Patients (n = 6; 40% in Group 2) who had undergone ultrasound before MRI were all in the delayed surgery group. A developing abscess could be the explanation, but it might also be possible that the ultrasound yielded a false-negative and caused a delay in obtaining appropriate imaging. Delays in imaging could contribute to delays in decision-making for surgery, as we hypothesized in the delayed surgery group in our cohort. Furthermore, due to the complex anatomy of the neck, some abscesses might have been challenging to reach for drainage, especially among small children and, for example, when located near the base of the skull.

The overall LOS median of 6.0 days for all patients and 5.5 days for those managed surgically was similar in a recent report by Wilkie in 2019, but slightly lower (4.7 days) for all patients in Cheng's report (2013) [2,12] although similar (5.5 days) for those who underwent surgery. Twelve patients (28.6%) were admitted to PICU. These numbers are higher than recent previously reported PICU admission, which varies from 2.5% to 15.2% [2,4,14]. As our cohort mainly consisted of surgically treated patients, they likely represent the more severe cases of pediatric DNI. The median length of stay at PICU was 2.0

days, which is comparable to the duration of 1.4 days reported by Elsherif and the median intubation period of one night by Page [14,16]. The complication rate was 14.3%: Sepsis, pneumonia, mediastinitis, Lemierre's syndrome, clival osteomyelitis and one cervical re-incision were described. Complication rates of 6.7%, 9.4% and 11.5% were reported by Cheng et al. (2013), Baldassari et al. (2011) and Elsherif et al. (2010), respectively [1,2,14]. Severe complications such as mediastinitis and Lemierre's syndrome were found in the conservatively managed group (Group 3). This may be due to the relatively small sample size and individual decision-making, as mentioned earlier.

Staphylococcus aureus (n = 7; 23.3%) and *Streptococcus pyogenes* (n = 7;23.3%) were equally presented in the bacterial cultures. DNIs have shown to be polymicrobial, and several studies have identified similar pathogens [2,8,10,16]. The percentage of anaerobic bacteria (n = 5; 16.7%) found in the cultures was considerably higher than previously reported [19]. However, this could be due to a good sampling technique rather than a real difference. Studies in the United States have stated MRSA as a major causative agent in pediatric DNIs [2,20]. We found MRSA in only one patient (3.3%), possibly due to the low frequency of MRSA colonization in general in Finland [21]. We observed no marked abnormalities in antibiotic susceptibility in other cultures.

The differentiation between cellulitis and an abscess can be challenging when using traditional ce-CT [22]. MRI has been classed as a valuable imaging modality for evaluating pediatric neck masses and neck infections in emergency settings [23,24]. Although the accuracy of ultrasound is limited, it has proven to be particularly useful for the initial evaluation of superficial pediatric neck infections [25]. In our study, MRI (57%) was the most common modality for the diagnosis and preoperative evaluation of pediatric DNIs. We found no difference in the correlation between ce-CT and MRI in comparison to the presence of pus in surgery. Previously, ultrasound has been utilized (together with ce-CT) due to its good availability and lack of ionizing radiation. However, MRI is now preferred in our practice because of its high feasibility and superior diagnostic accuracy [24].

Several authors have stated that conservative first line treatment is a good option in selected cases, especially in cases of smaller sized (under 25 mm diameter) pediatric abscesses among older children with a stable clinical condition, no airway obstruction and a single site infection [2,10,12–14]. Lawrence and Bateman reviewed the current literature in 2017 and proposed an evidence-based algorithm for the management of pediatric DNIs [11]. The indications for surgical intervention were signs of airway compromise, the presence of complications, no clinical improvement after 48 h of intravenous antibiotics, an abscess of >22 mm on CT imaging, age of <4 years or PICU admission. According to our study, active surgery (<2d after admission) was associated with lower LOS (p = 0.009). Moreover, we found a trend towards increased morbidity in the other outcome variables (PICU admission, complication rate). However, the limited number of patients reduces the statistical significance of this. We agree with the algorithm and the option of initial conservative strategy. Nonetheless, we wish to emphasize that our results suggest that decreasing delays in imaging could help achieve lower LOS in addition to timely, correct diagnosis. Moreover, if no clinical improvement is detected, actions to avoid delays to surgical intervention should be prompt.

We acknowledge that our study is limited by its retrospective nature and relatively small sample size. An obvious problem is how to standardize the initiation of antibiotic treatment retrospectively. We believe that registering clinical symptoms, laboratory values and imaging made these groups relatively comparable. However, there is a certain amount of uncertainty over diagnosis at initial presentation. Further prospective research is needed.

5. Conclusion

In this study, early imaging and surgical intervention promoted the recovery of severe pediatric deep neck abscess patients, shown by a reduction in the length of hospitalization. Although the imaging of young children may require sedation or even anesthesia, delays should be avoided when DNI is suspected. Younger age (<7 years) was associated with an increased need for PICU treatment. MRI seems to be a feasible option for the accurate diagnosis of pediatric DNIs without ionizing radiation.

Ethical approval

This research involved only patient charts. Institutional permission (Turku Clinical Research Center: TO6/040/19) was approved for the study on September 30, 2019.

Informed consent

This retrospective chart review was conducted using already available data, and according to Finnish legislation no informed consent was necessary.

Declaration of competing interest

The authors declare no potential conflicts of interests. No funding was received for this study.

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