

**DEEP NECK SPACE INFECTIONS IN INFANTS AT A TERTIARY REFERRAL CENTRE: A CASE
REVIEW**

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DEEP NECK SPACE INFECTIONS IN INFANTS AT A TERTIARY REFERRAL CENTRE: A CASE REVIEW

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Abstract

Background: Persistent upper respiratory tract infections in infants can lead to retropharyngeal lymphadenitis. If untreated, they can progress to deep neck space infections (DNSI).

Objective: To review surgical management of DNSI in infants, and to determine optimum timing of surgical drainage, and sequelae thereof.

Methods: A retrospective study of infants presenting with DNSI, was conducted at Red Cross War Memorial Children's Hospital, Cape Town, between May 2018 to March 2022. Medical folders were reviewed, data collected included demographics, clinical presentation, investigations, management, and post-operative course. Ethics approval was obtained prior to commencement.

Results: Six children with DNSI were identified, aged between 3-12 (average 6.7) months. None had any preceding comorbidities; 2/6 (33%) children incidentally tested positive for Covid-19; 4/6 (67%) had preceding URTI, 3/4 (75%) having commenced antibiotics prior to presentation. Common clinical findings were neck swelling in 5/6 (83%) and fever in 6/6 (100%); stridor in 4/6 (67%) and dysphagia in 3/6 (50%). The average white cell count (WCC) was 21.5 (range 12.6-34.3) $\times 10^9/L$. 3/6 infants had measured procalcitonin levels between 0.23-2.74 (average 1.10) ng/ml. DNSI was identified on CT imaging in all cases in the following deep spaces: retropharyngeal 6/6 (100%); parapharyngeal 4/6 (67%); superior mediastinum 5/6 (83%); anterior cervical 2/6 (33%); posterior mediastinum 1/6 (17%) and paratracheal 1/6(17%). Abscess size of more than 3cm with airway displacement was seen in all cases. 5/6 (83%) infants underwent surgical intervention within 24hours of presentation. Delayed surgical intervention in 1/6 (17%) resulted in "antibioma" formation and delayed

surgical drainage. *Methicillin sensitive staphylococcus aureus* (MSSA) was cultured in 5/6 (83%) cases; no organisms were identified in the remaining case. 5/6 (83%) were managed post-operatively in the ICU for 3-9 (average 5.8) days. Empiric intravenous therapy was commenced in all cases, namely, Co-Amoxiclav (4/6) and Piperacillin/Tazobactam (2/6). Amikacin was additionally administered in 1 case for presumed nosocomial respiratory infection prior to DNSI management. Culture-directed therapy modified treatment to Cephalexin/Flucloxacillin in 2/6 cases. Neck drains were removed after an average of 2.8 (range 1-6) days when output was minimal. Duration of hospital stay was 13 (range 5-19) days. There were no mortalities.

Conclusion: DNSI is a rare but serious complication of progressive retropharyngeal lymphadenitis resulting from non-resolving or worsening URTIs in infants. This was observed in all six cases. Typical presentation includes neck swelling, fever, and airway compromise often requiring prompt airway management with source control. Recommended management includes CT imaging of head, neck and chest to determine extent of spread, appropriate intravenous antibiotics, and prompt surgical drainage. Medical therapy alone can risk antibioma formation, with inevitable surgical clearance of sepsis.

Keywords: deep neck space infection; infant; paediatric; cervical lymphadenitis, mediastinitis; antibioma, retropharyngeal lymphadenitis, surgical drainage

HREC Ethics Approval number: 502/2021

(This is a new research)

Introduction

Persistent pharyngolaryngeal infections may lead to retropharyngeal lymphadenitis which, if left untreated may result in deep neck space infections (DNSI). DNSI involves the fascial compartments of the neck and poses a serious threat to life, especially in the paediatric population. Prompt recognition and management is of paramount importance to prevent devastating complications like airway obstruction, mediastinitis, jugular vein thrombosis, pericarditis, and pleural empyema. Although the incidence of DNSI was much higher in the pre-antibiotic era, it still causes a significant health problem in developing countries and may result in significant morbidity and mortality (1). Diagnostic and therapeutic delays can therefore lead to unfavourable outcomes. A 1992 statement by Mosher et al, remains true today that “pus in the neck calls for the surgeon’s best judgement, his best skill, and often for all his courage”. Diagnosis of paediatric DNSI remains a challenge to both paediatricians and otorhinolaryngologists owing to the insidious onset and often prior antibiotic treatment which may alter the clinical presentation (1, 2). Predominant clinical features include fever, neck mass or swelling, dysphagia, drooling, restricted neck movement, trismus and most important - airway compromise (3, 4). Computed Tomography (CT) imaging is the investigation of choice, and although it has limited specificity in differentiating an abscess from cellulitis, it is often adequate to guide therapy (5-7). In selected cases with uncomplicated CT findings, intravenous antibiotics and supportive medical therapy may suffice. Immediate surgical drainage remains the mainstay of treatment for complicated cases or in cases of failed medical therapy. It is important to mention that the decision to institute medical therapy alone or with surgical management, relies on the surgeon’s clinical judgement, considering the available resources at hand (5, 6, 8, 9). The primary objective of this study is to review the surgical management of DNSI in infants, and to determine optimum timing of surgical drainage, and sequelae thereof.

Methods

A retrospective review of infants managed for DNSI by the Division of Paediatric Otorhinolaryngology at Red Cross War Memorial Children's Hospital, a paediatric tertiary referral centre, was performed. The inclusion criteria were infants aged 1 month to 1 year, with DNSI who were admitted and underwent imaging (CT/MRI) prior to intervention and received inpatient intravenous antibiotics. Children less than 1 month and more than 1 year of age, children who had no CT/MRI imaging and who fell outside our study review timeline, were all excluded. The study was conducted between May 2018 and March 2022 and was approved by the UCT Human Research Ethics Committee (HREC:502/2021). Medical folders of all DNSI cases were reviewed and data collected included demographics, clinical signs and symptoms, radiological investigations, laboratory investigations, medical therapy including antibiotic therapy and duration, surgical therapy and timing thereof, microbiology results, and post-operative courses. Response to therapy was recorded as abscess resolution/progression/recollection, duration of stay in hospital, and whether further surgical intervention was performed. Descriptive statistics with univariable analysis were used to describe demographics, clinical characteristics, surgical findings, clinical course and final outcomes. Data was presented as mean +/- standard deviation and median with categorical variables presented as frequency and percentages.

Results

Six infants with confirmed DNSI between May 2018 and March 2022 were identified. Four (67%) were males, with a mean age at time of presentation of 6.7 (range 3-12) months. The mean birth weight was 3.0 (range 2.1-3.7) kgs; 2/6 (33%) had low birth weight. The mean weight at presentation was 7.6 (range 4.4-10.3) kg. Immunisation was up to date in 4/6 (67%). Four (67%) infants had a preceding upper respiratory tract infection (Table 1); 3 commenced antibiotics prior to presentation. One received Ampicillin; another received Co-amoxiclav; the remaining infant received antibiotics but the name was not documented. The remaining 2/6 (33%) infants neither had a preceding upper respiratory tract infection nor did they receive antibiotics. The common clinical findings were fever 6/6 (100%); neck

swelling 5/6 (83%); stridor 4/6 (67%) and dysphagia 3/6 (50%) (Table 3). The mean white cell count (WCC) was 21.5 (range 12.6-34) $\times 10^9/L$. The mean C-reactive protein level was 96.7 (range 3-163) mg/L done in 5/6 infants. The mean procalcitonin level was 1.10 (range 0.23-2.74) ng/mL done in 3/6 infants. The mean haemoglobin level was 10 (range 8.5-12) g/dL. 2/6 infants incidentally tested positive for Covid-19 on admission. 2/6 infants were tested for HIV, were negative. 5/6 cases had CT imaging; the remaining case had an MRI for suspected posterior mediastinal mass. Radiological findings revealed the following deep neck space involvement; retropharyngeal 6/6 (100%); superior mediastinum 5/6 (83%); parapharyngeal 4/6 (67%); anterior cervical 2/6 (33%); posterior mediastinum 1/6 (17%); paratracheal 1/6(17%) and paravertebral in 1/6 (17%) (Table 2) (Figure 1). Abscess collections were found to be more than 3cm in length in at least one plane in all the cases; and all cases had some degree of airway displacement. Surgical drainage was performed on all patients. 5/6 (83%) infants underwent prompt surgical intervention (within 24 hours). The remaining case was initially treated with intravenous antibiotic therapy and underwent delayed surgical intervention 6 days later. Antibiooma formation, which is a thick-walled abscess surrounded by fibrotic tissue was identified at surgery (Figure 2), which was subsequently removed. One patient required thoracotomy for posterior mediastinal involvement, performed by cardiothoracic surgery. Personal protective equipment was used for Covid-19 positive infants during surgery. *Methicillin sensitive staphylococcus aureus* (MSSA) was cultured in 5/6 (83%) cases, and the remaining infant cultured no organisms (Table 4). This infant received intravenous Co-amoxiclav prior to referral. Gene Xpert was negative for *Mycobacterium tuberculosis* in all cases. Histology specimens sent in 3/6 infants showed findings consistent with abscess wall, negative for acid fast bacilli (AFBs). 5/6 (83%) were managed in the ICU post-operatively for 3-9 (average 5.8) days. The remaining infant with transoral drainage alone was admitted to high care. The mean amount of pus drained was 17.5 (range 10-30) mls, in 4/6 cases with a documented volume. Empiric intravenous therapy commenced in all cases; 4/6 with Co-amoxiclav; 2/6 with Piperacillin/Tazobactam, 1 of these had additional Amikacin for presumed nosocomial chest infection prior (Table 5). Culture-directed regimens modified therapy to Cephalexin in 1/6 and Flucloxacillin in 1/6 cases. Neck drains were removed after a mean of 2.8 (range 1-6) days based on output. The mean in-hospital stay was 13 days (range 5-19) days. All infants recovered and were doing well at 6-week follow-up.

Discussion

DNSI were associated with significant morbidity and mortality in the pre antibiotic era. We reviewed the folders of infants that were admitted with DNSI and met our inclusion criteria over 46 months. We found that most of the infants presented with neck swelling, fever and upper aerodigestive symptoms with a history of a preceding URTI. All the infants in our review had DNSI involving at least 2 deep neck spaces. All underwent surgical drainage with the infant who underwent delayed surgical drainage developing an abscess. Even though there were no fatalities in our review, clinicians should be vigilant in monitoring infants with DNSI and have a low threshold for surgical intervention.

The deep spaces of the neck lie within the layers of cervical fascia that serve as natural barriers of resistance to spread of infection. However, as these spaces communicate with each other, the fascial planes surrounding them provide potential routes for spread of infection. Deep neck spaces are defined in relation to the hyoid bone, suprahyoid (peritonsillar, submandibular, parotid, parapharyngeal, buccal, masticator, temporal), transhyoid (retropharyngeal, danger, prevertebral, carotid), and infrahyoid (anterior visceral, pretracheal) (10).

Deep neck space infection (DNSI) is defined as infection involving potential neck spaces where pus tracks along the fascial planes of the neck (11). Without prompt investigation and surgical drainage, this can be fatal. The advent of antibiotic therapy, however, has changed the clinical course of DNSI. Notwithstanding, rapid disease progression still poses a serious threat to life in vulnerable groups like infants. This is typically due to associated complications in adjacent vital structures, and includes upper airway obstruction with or without acute respiratory distress syndrome, mediastinitis, intracranial complications, jugular vein thrombosis and septicemia (10, 11). Furthermore, drainage of DNSI in children can often be challenging due to involvement of more than one deep neck space and the close proximity to neurovascular structures (12).

Chung-Ming Huang et al demonstrated that the most common antecedent illness in children who presented with DNSI was upper respiratory illness, followed by dental infections and congenital malformations like branchiogenic cysts especially in patients with recurrent neck abscesses. However, their review included patients with DNSI under the age of 18 years, while our study focused on infants alone (3). *Swain SK et al* described odontogenic infections to be the most common aetiology for DNSI in children less than 16 years, followed by upper respiratory illness, parotitis, foreign body, congenital cysts, tuberculosis, trauma, sialadenitis and idiopathic (4). In our series, the most common antecedent illness was an upper respiratory illness.

In our cohort, the commonest presenting symptom was fever, found in all cases. The second commonest presenting symptoms were neck swelling and dysphagia in 5/6 (83%) cases. Other presenting symptoms included stridor and URTI symptoms. *Chuang-Ming Huang et al*, found neck swelling to be the commonest presenting symptom in 82.7% of their cases. This is in keeping with our study and most literature, and exclusion of DNSI is therefore warranted in any child, regardless of age, who presents with neck swelling (4, 13, 14). Other studies have demonstrated that neck swelling, fever, cervical adenopathy, poor oral intake and neck stiffness are common in all paediatric age groups with DNSI (15). Also of note, it is often challenging to diagnose DNSI in children due to difficulties in identifying symptoms and often challenging physical examinations due to poor cooperation, generally with children, worse even, in cases presenting with subtle signs and symptoms (3, 4, 14). Stridor is the most important life-threatening symptom as it signifies airway compromise - securing and maintaining an adequate airway must be the first priority, and is the primary reason why otolaryngologists are consulted (1, 4).

Initial laboratory investigations should include a full blood count, urea and electrolytes, blood glucose and inflammatory markers like C-reactive protein and procalcitonin (16). Blood cultures and pus swabs for cultures should be taken, ideally prior to commencing antibiotic therapy. Fungal specimens should routinely be obtained in immunocompromised patients and *Mycobacterium tuberculosis* (TB) cultures in high burden areas (11, 17). The high burdens of HIV and TB necessitate routine TB culture of all microbiology specimens in LMIC settings. Of note, it is often difficult to send specimens prior to starting antibiotics, as

most children are referred to our centre having already been treated or partially treated with empiric antibiotics for a preceding URTIs.

Bacterial cultures usually yield a polymicrobial picture, reflecting the possible origin of DNSIs from oropharyngeal flora or odontogenic source. This includes but is not limited to aerobes like *Streptococcus viridans*, *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Streptococcus pyogenes*, *Neisseria species*, *Haemophilus influenzae*. Anaerobes commonly isolated are *Peptostreptococcus*, *Bacteroides fragilis*, pigmented *Prevotella*, *Porphyromonas species*, *Fusobacterium species* and *Eikenella corrodens*. Methicillin resistant *Staphylococcus aureus* has been seen to be increasing in incidence in intravenous drug abusers, immunocompromised patients and in infants. *Klebsiella pneumoniae* is still a common cause of DNSI in poorly controlled diabetics. In our study, *Staphylococcus aureus* was isolated in 5/6 (83%) children (9, 10, 14, 18, 19).

Contrast enhanced CT scan of the head, neck and upper mediastinum is the gold standard imaging modality in suspected cases of DNSI. It is important in characterizing the nature of DNSI, involved deep spaces, aerodigestive tract involvement with airway displacement, highlighting a source of stridor, and for surgical planning. CT imaging has a sensitivity of 64-100% for detecting DNSI, and cases where CT imaging cannot differentiate between a collection and cellulitis should be either confirmed by fine needle aspiration or by finding of pus intraoperatively if incision and drainage is performed. Huang Chung-Ming et al recommended CT imaging on all patients exhibiting signs and symptoms of DNSI. In addition, Eliashar R et al showed that CT imaging was useful to monitor response to antibiotics and it prevented unnecessary surgical explorations (3, 7, 10, 11, 20). It is also affordable and readily available. In our series 5/6 (83%) underwent CT imaging and 1/6 (17%) had MRI for suspected a posterior mediastinal mass which was confirmed to be a retropharyngeal abscess with posterior mediastinal extension. All the patients 6/6 (100%) in our series had abscesses more than 3cm in length in one plane, involvement of more than 2 deep neck spaces and some degree of airway displacement. Lateral neck x rays have been used to screen for retropharyngeal and parapharyngeal abscesses, but current evidence advises against its use due to low sensitivity, lack of stringent reporting criteria and poor guidance for surgical management (11, 20). Ultrasound has been shown to be more

accurate to differentiate a drainable abscess from cellulitis. However, it cannot accurately locate deep-seated collections, as well being operator dependent. Ultrasound should be used to supplement CT and MRI imaging in cases where there is uncertainty about a collection or to guide needle/catheter aspiration of superficially located uniloculated collections. MRI provides better soft tissue definition but often requires general anaesthesia in infants, which is time consuming and may delay surgical intervention (11, 21). In addition, MRI is not as readily available as CT scanning in LMIC settings.

The management of DNSI in infants is often challenging and requires a multidisciplinary team approach. The choice of antibiotic therapy should be guided by the microbiology profile and local antimicrobial sensitivities, with infectious diseases input. Empiric antibiotics should target aerobic and anaerobic bacteria. Either penicillin in combination with a *Beta lactamase* inhibitor (such as Amoxicillin or Ticarcillin with Clavulanic acid) or a *Beta lactamase* resistant antibiotic (example: Cefoxitin, Cefuroxime, Imipenem, or Meropenem) in combination with a drug that is highly effective against most anaerobes (example: Clindamycin or Metronidazole) is recommended for empiric coverage (10, 11).

Medical therapy alone may suffice in selected, uncomplicated cases. Cheng et al. in a series of 178 children demonstrated that the risk factors for failed medical management were age less than 51 months, intensive care admission, and abscess size greater than 2.2cm on CT scan. There was no statistically significant increase in the length of hospital stay in those who underwent delayed surgical drainage (9). In our series, medical therapy alone resulted in progressive symptoms with persistent rim enhancing collections identified on repeat CT imaging (Figure B). Antibiofilm formation (Figure A) was identified at surgical intervention, due to delay in drainage. Clear indications for surgical intervention include airway compromise, septicaemia, infection extending into the mediastinum, failed medical therapy after 48 hours of appropriate parenteral antibiotics, and diabetic patients (typically prone to developing complications). Additional indications include abscesses of more than 3cm in length, involvement of multiple neck spaces, and involvement of the carotid sheath, anterior visceral and prevertebral spaces (10, 22). In our series all patients underwent surgical intervention, and the indications were airway compromise, involvement of multiple

neck spaces, failed medical management, and infection extending into the mediastinum. All the patients were successfully discharged and were stable at follow up.

Our study was limited by sample size, a single centre and by retrospectively collected data. In addition, we were unable to eliminate institutional bias since the acutely ill and more sick children were most likely to be the ones referred to our tertiary centre. Lastly, we were unable to eliminate surgeon bias in decision-making around proceeding to surgery. However, based on our case series, all children improved following surgery, which is therefore our recommendation, in particular, early surgical drainage. Factors that contributed to successful outcomes in our cohort include surgery for a) infants who present with abscesses of more than 3cm in length, b) multiple involved spaces, c) airway compromise, d) infection extending into the mediastinum, and e) those who have failed medical management.

Conclusion

DNSI is a very rare but serious complication of progressive retropharyngeal lymphadenitis resulting from non-resolving URTIs, as was observed in our cases series. Typical presentation includes fever, neck swelling, airway compromise and dysphagia. Infants who present with a triad of fever, neck swelling, and poor feeding should be investigated to exclude DNSI. Respiratory distress with stridor in these infants also warrants prompt airway management. Prompt CT imaging should be followed by directed surgical drainage with definitive airway management and appropriate antibiotic therapy to be instituted early, with choice of empiric antibiotic therapy determined by local microbiology practice. Medical therapy alone can result in “antibioma” formation which may delay inevitable surgical drainage. Further research is needed to ascertain which group of infants with DNSI are amenable to medical therapy alone to avoid the sequelae of delayed surgical intervention.

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Conflicts of interest: None

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Tables and Figures

Aetiology	Total		Cases					
	No	%	1	2	3	4	5	6
URTI	4	67	+	+	-	-	+	+
Idiopathic	2	33	-	-	+	+	-	-

TABLE 1: Aetiology of Deep Neck Space Infections (DNSI)

Space	Total		Cases					
	No	%	1	2	3	4	5	6
Retropharyngeal	6	100	+	+	+	+	+	+
Sup. Mediastinum	5	67	+	+	+	-	+	+
Parapharyngeal	4	83	+	-	+	+	+	-
Anterior Cervical	2	33	-	-	+	-	+	-
Paratracheal	1	17	+	-	-	-	-	-
Post. Mediastinum	1	17	-	-	-	-	-	+
Paravertebral	1	17	-	-	+	-	-	-

TABLE 2: Deep Neck Spaces Involved

Clinical Presentation	Total		Cases					
	No	%	1	2	3	4	5	6
Fever	6	100	+	+	+	+	+	+
Neck Swelling	5	83	+	+	+	+	+	-
Poor Feeding	5	83	-	+	+	+	+	+
Stridor/UAO	4	67	+	+	+	-	-	+
URTI Symptoms	4	67	+	+	-	-	+	+
Dysphagia	3	50	-	+	+	+	-	-

TABLE 3: Clinical Presentation

Organism	Total		Cases					
	No	%	1	2	3	4	5	6
<i>Staph. Aureus</i>	5	83	+	-	+	+	+	+
No growth	1	17	-	+	-	-	-	-

TABLE 4. Organism Cultured

Choice of Antibiotic	Total		Cases					
	No	%	1	2	3	4	5	6
Co-Amoxiclav	5	83	+	+	-	+	+	-
Piperacillin/Tazobactam	1	17	-	-	+	-	-	-
Amikacin			-	-	-	-	-	+

TABLE 5. Choice of Antibiotic

Figures

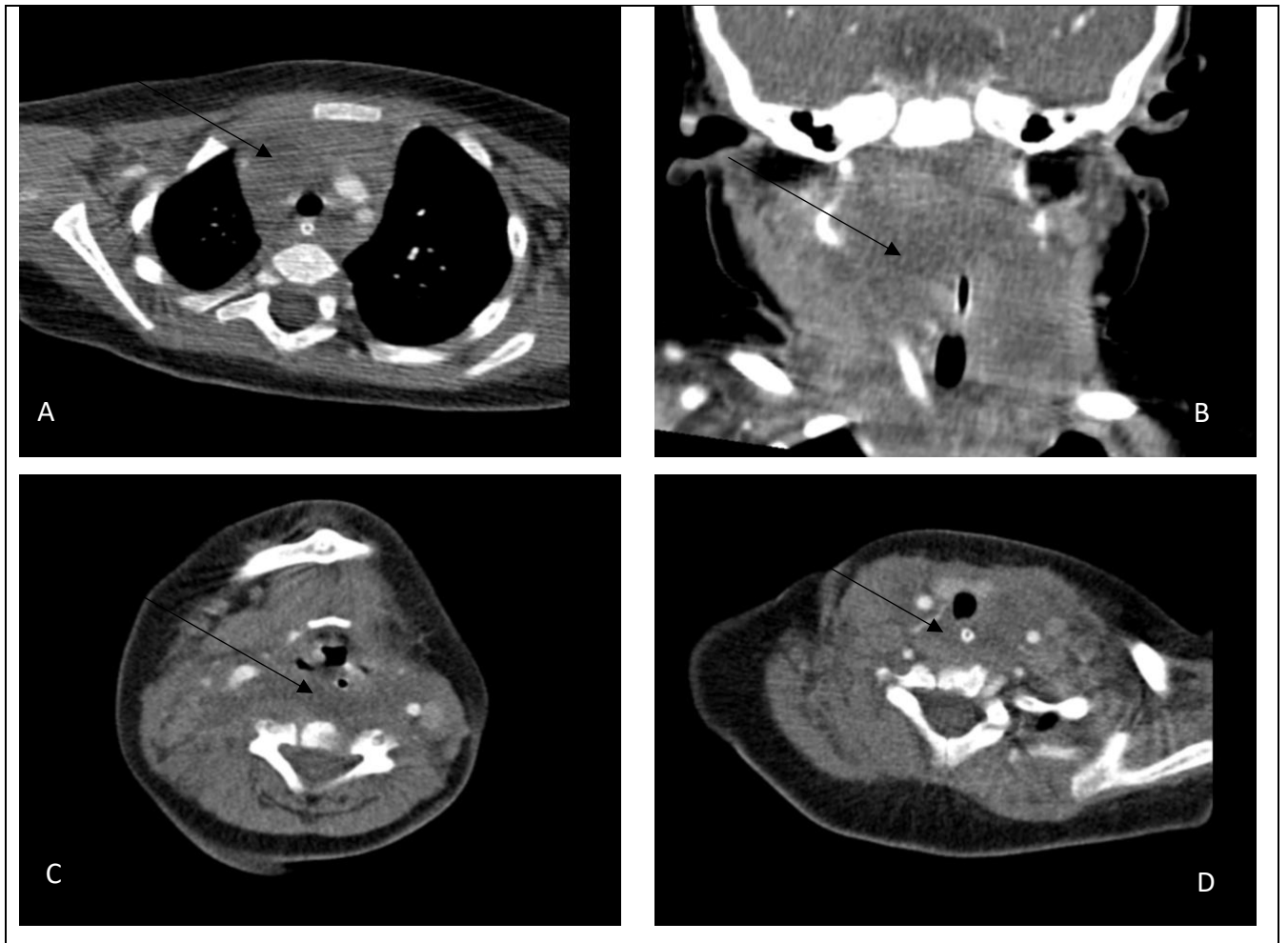


FIGURE 1: CT images of head, neck and chest at presentation showing hypodense collection (arrow); A, axial view of the superior mediastinum; B, coronal view showing parapharyngeal and superior mediastinal extension; C, axial view showing retropharyngeal and parapharyngeal collection; D, axial view showing retropharyngeal and superior mediastinal collection.

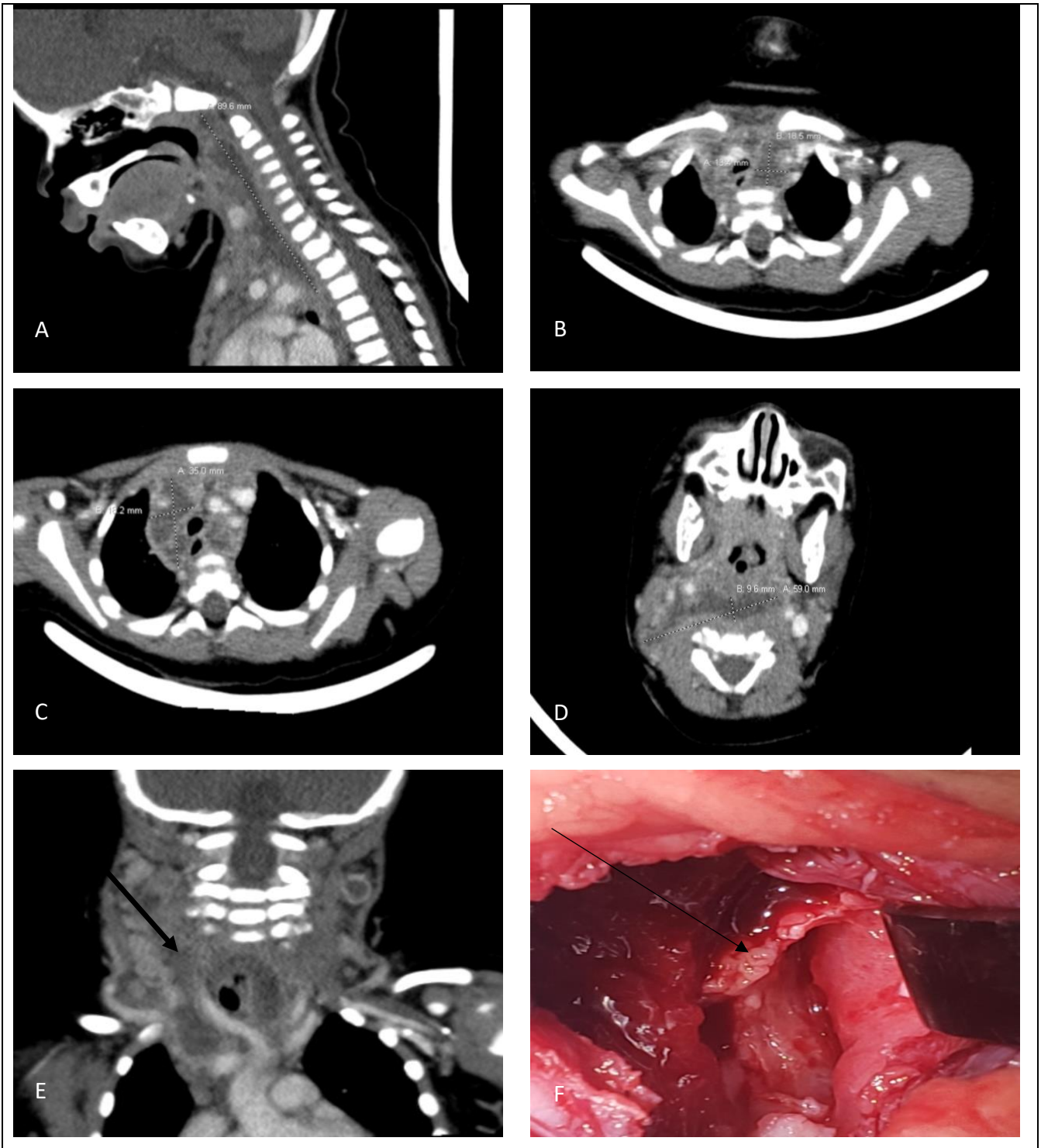


FIGURE 2: CT images after 5 days of antibiotic treatment showing areas of hypodense collections; A = Sagittal view; B + C = axial view showing the superior mediastinal extension; D = axial view showing the retropharyngeal space collection; E = coronal view showing (thick arrow) the parapharyngeal and superior mediastinal extension; F = intraoperative view showing an "antibioma" (thin arrow) in the superior mediastinum.