

A New Trend in the Management of Pediatric Deep Neck Abscess: Achievement of the Medical Treatment Alone

Original Investigation ►

 Aslı Çakır Çetin, Yüksel Olgun, Arif Özses, Taner Kemal Erdağ
 Department of Otorhinolaryngology, Dokuz Eylül University School of Medicine, İzmir, Turkey

Abstract ►

Objective: Albeit the traditional opinion that advocates a routine surgical drainage for the treatment of an abscess, the case series presenting high success rates of the medical therapy alone is increasing in deep neck abscesses of childhood. This research focuses on children whose deep neck abscess fully disappeared after only medical treatment.

Methods: In a retrospective study, we evaluated medical records of 12 pediatric (<18 years old) cases diagnosed with deep neck abscess or abscess containing suppurative lymphadenitis and treated with only medical therapy between 2010 and 2015 for age, gender, treatment modality, parameters related to antimicrobial agents, location of the infection, etiology, symptoms, duration of hospital stay, characteristics of the radiological and biochemical examination findings, and complications.

Results: The mean age of 10 male and two female children was 5.9 years (range, 1-17 years). Baseline and the last control's mean values of white blood cell (WBC), C-reactive

protein, and erythrocyte sedimentation rate were 18,050/ μ L, 99.8 mg/L, 73.1 mm/h, and 8,166/ μ L, 34.1 mg/L, 35.3 mm/h, respectively. Contrast-enhanced neck computed tomography demonstrated an abscess in seven cases and an abscess containing suppurative lymphadenitis in five cases. The largest diameter of the abscess was 41 mm. All cases were given broad-spectrum empirical antibiotherapy (penicillin+metronidazole, ceftriaxone+metronidazole, or clindamycin). No medical treatment failure was experienced.

Conclusion: Independent of age and abscess size, if the baseline WBC is $\leq 25.200/\mu$ L, if only two or less than two cervical compartments are involved, if there are no complications in the admission, and if the etiological reason is not a previous history of trauma, surgery, foreign body, and malignancy, pediatric deep neck abscess can be treated successfully with parenteral empirical wide-spectrum antibiotherapy.

Keywords: Pediatric, neck, abscess, medical treatment

Introduction

Deep neck infections (DNI) refer to various infections like cellulitis, abscess, or necrotizing infections occurring within the layers of cervical fascias. DNIs are named according to their anatomical locations such as submandibular, parapharyngeal, peritonsillar, buccal, parotid, masticator, temporal, retropharyngeal, prevertebral, danger space, carotid, pretracheal, and anterior visceral (1,2). DNIs are rare pathologies in the pediatric age group. The incidence is introduced in 46 per 100,000 and is most common in children younger than six years (3). Usually, upper respiratory tract infections such as rhinosinusitis, tonsillitis, and pharyngitis and less often dental carries underlie the pathophysiology of pediatric DNIs. However, sporadic cases can also be encountered (3). According to the general aspect, DNIs can be treated surgically or med-

ically. Nearly 10-15 years ago, surgical treatment remained the first-step approach in most deep neck abscess cases. On the other hand, particularly considering the pediatric age group, recent reports represent lots of cases which advocate the success of conservative medical treatment alone (4-6). Parenteral antibiotics combined with a close observation maintain the new therapeutical approach. Probably, the low incidence of severe disease gets some authors to prefer conservative treatments to surgery in children (4, 5). Likewise, such life-threatening complications like airway compromise are experienced very rarely in childhood, which allows physicians to observe the child clinically for a while and avoid from over-treatment and related complications (5). However, Yang et al. (6) suggested that children required a higher rate of surgical drainage as compared to adults. Likewise, Kaya et al. (7) supported a traditional surgical



This study was presented at the 38th Turkish National Congress of Otorhinolaryngology Head and Neck Surgery, 26-30 October 2016, Antalya, Turkey.

Address for Correspondence: Aslı Çakır Çetin
E-mail: aslicakir84@hotmail.com

Received Date: 13.12.2016

Accepted Date: 31.01.2017

Available Online Date: 22.05.2017

© Copyright 2017 by Official Journal of the Turkish Society of Otorhinolaryngology and Head and Neck Surgery Available online at www.turkarchotorhinolaryngol.org

DOI: 10.5152/tao.2017.2181

drainage method for the treatment of a deep neck abscess in childhood. On the other hand, the failure rate of the medical management in pediatric age group has not been detailed in the literature (2). Contradictions based on the topic inspired us to discuss our clinical experience. In the contemporary research, it was aimed to present a pediatric case series diagnosed with deep neck abscess and treated with medical therapy alone and review the relevant literature.

Methods

After obtaining the approval of the Local Institutional Review Board (Resolution number: 2016/08-29, protocol number: 2599-GOA) according to the WMA Declaration of Helsinki-Ethical Principles for Medical Research Involving Human Subjects and the medical consents of each individual's parents, we conducted a retrospective patient record study. Medical records of the pediatric patients who were diagnosed with DNI from 2010 to 2015 and treated in our Otolaryngology department were examined. Inclusion criteria were age less than 18 years and a diagnosis of DNI. In this way, 42 patients were received. Among them, 30 patients met the exclusion criteria which include non-abscess DNI (only soft tissue inflammation, phlegmon, cellulitis, and non-suppurative non-pus-filled lymphadenitis), surgically treated DNI, DNI due to penetrating or blunt trauma of neck, secondary to neck surgeries, related to foreign bodies, and malignancy.

Similar to our previous clinical experience, children who presented with any of these symptoms or findings regarding dyspnea, stridor, contractions of the supplementary respiratory muscles, radiological confirmation of abscess occupying more than two cervical compartments with or without collapsing the airway, or any other vital anatomical structures were considered as non-favorable candidates for conservative treatments and therefore were referred to surgical therapy. Likewise, children resistant to medical care were also directed to needle punctuation and aspiration or transoral and cervical surgeries. The success of the treatment was decided via monitoring the daily course of fever, laboratory results (mainly the positive alterations in acute-phase reactants), and symptom recovery. Besides, all the cases were administered preliminary intravenous antibiotics until they showed a worsening in general status which made us give up the conservative therapy and consult on surgical interventions.

After the rejection of those 30 cases, the remainder 12 were reviewed and investigated for age, gender, treatment modality, parameters related to the antimicrobial agents, location of the infection, etiology, symptoms, duration of hospital stay, characteristics of the complementary diagnostic tools like radiological and biochemical examination findings, and complications. Descriptive data analysis was done on a Microsoft Office Excel spreadsheet and software program (Microsoft Office, Excel 2013, USA). All data were expressed as mean, range and percentiles.

Results

According to the epidemiological data, the mean age was 5.9 years (range, 1-17 years), and the gender ratio was 10 males to

two females. The most common etiological factor was the history of a previous upper respiratory tract infection immediately before the DNI except for one case which probably commenced after dental caries. The most frequent presentation was a neck swelling. Other symptoms included fever, limited neck movement, torticollis, and other signs of inflammation such as calor, dolor, and rubor. None of them presented with a symptom of airway compromise, motor or sensory, neurological deficit, or impaired consciousness. All the children were hospitalized and treated medically with intravenous antibiotics. Complementary medicine comprised anti-inflammatory, antipyretic, analgesic drugs and hydration supplement. Close clinical follow-up and physical examination were standard. Fever was measured at least six times a day and more in the case of necessity. Routine biochemical analyzes such as complete blood count, C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), liver enzymes (alanine transaminase and aspartate transaminase), and renal function tests (creatinine, blood urea nitrogen, total protein, albumin, serum sodium, and potassium electrolytes) were performed at the initiation and in every 2 or 3 days during the hospitalization period. In the case of constant or increasing fever with or without a deterioration in overall condition, blood cultures were tested. Radiological diagnostic tools such as contrast-enhanced neck computed tomography (CT) were performed at the beginning of the therapy to agree on the right treatment modality. None of the cases were evaluated with magnetic resonance imaging (MRI). CT scans of cases VII, VIII, IX, and XII are presented in Figure 1-4, respectively. The primary location sites of DNI (10 cases) were parapharyngeal and retropharyngeal spaces. Radiological reports were compatible with an abscess in seven cases, whereas a suppurative lymphadenitis containing pus (abscess) and surrounding soft tissue inflammation in the rest.

The laboratory examinations resulted in a high count of white blood cell (WBC), CRP, and ESR before the beginning of the medical treatment. However, no abnormalities were observed in the biochemical tests. All of the patients underwent intravenous (iv) antibiotic therapy immediately. The mean values of the baseline (the first day of hospitalization and parenteral treatment) WBC, CRP, and ESR were 18,050/ μ L (10,600-25,200), 99.8 mg/L (9-190), and 73.1 mm/h (39-100), respectively. Subsequent laboratory tests which are performed with a 2 or 3 days' interval showed a declining trend in WBC, CRP, and ESR. The mean values of the last control (the day before the discharge from hospital) WBC, CRP, and ESR were 8,166/ μ L (5,200-12,000), 34.1 mg/L (2.1-101), and 35.3 mm/h (8-60), respectively. Healing parameters such as improvement in neck's range of motion, mouth openness, oral intake, and general health status were visible in all cases. Furthermore, each case underwent neck ultrasonography before the discharge from hospital to confirm the treatment success. No surgical intervention, even needle punctuation and aspiration or pus and aspirate culture, was required. None of the patients had neurological deficit either in the beginning or during the clinical follow-up course, and none of them had a fever more than 38°C except for the first 24 hours. No compli-



Figure 1. The view of the left posterior cervical abscess of case VII on axial neck CT. The white dotted line A indicates the long diameter (12.1 mm) of the abscess



Figure 3. The axial neck CT image demonstrating the left parapharyngeal and retropharyngeal abscess in case IX. The white dotted lines C (18.7 mm) and D (12.5 mm) show the long diameter of abscesses of parapharyngeal and retropharyngeal spaces, respectively



Figure 2. The axial CT scan of case VIII, showing the right parapharyngeal and retropharyngeal abscess. The dotted white lines A (13.8 mm) and B (16.2 mm) refer to the length of the long axis of abscesses located in parapharyngeal and retropharyngeal spaces, respectively

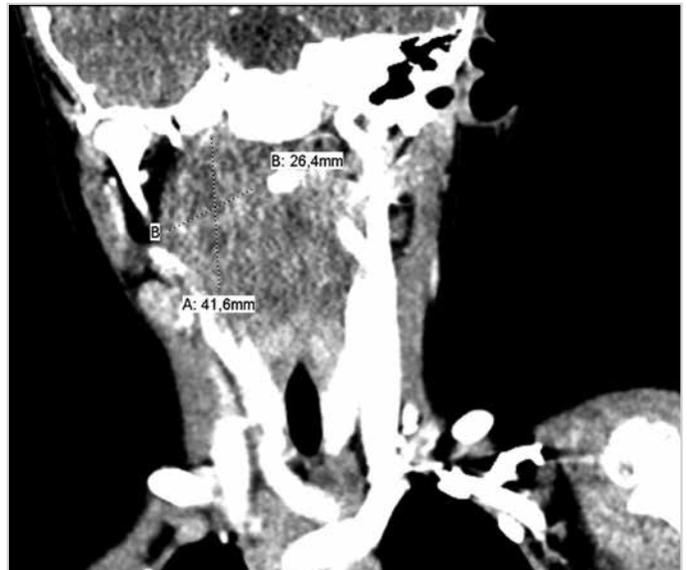


Figure 4. The coronal neck CT of case XI, presenting the abscess which filled the parapharyngeal and retropharyngeal spaces of case XI. The white dotted lines A (41.6 mm) and B (26.4 mm) point to the vertical and transverse axis length of the abscess

cations and no mortality were experienced either. None of the patients required renewal of CT. No microbial analysis was done due to the lack of needle aspiration or surgical drainage. An empirical antibiotic regimen was employed. Penicillin, ceftriaxone, metronidazole, and clindamycin were among the preferred antibiotics. All the patients stayed at the hospital during iv antibiotic application. The mean hospitalization time was 7.16 (range, 5-15) days.

Age, gender, DNI location, neck CT findings, laboratory results, and parameters related to antibiotic regimen are summarized in Table 1.

Discussion

Albeit the general consideration that children are less likely to experience DNI than adults and are better candidates for conservative and medical treatments, a recent literature against this preconception prompted us to review our experience (4, 8, 9). Yang et al. (9) discussed 130 patients in their study that included both adult and child patients. The most common sites of DNI in the children group were parapharyngeal, submandibular, and retropharyngeal spaces. The impressive result of their study was the higher necessity rate of surgery in pediatric group. The authors also reported a slightly higher complication rate (9%) as compared to the literature. On the contrary, com-

Table 1. Demographic data of the children and parameters associated with DNI

Case number	Age, y	Gender	Etiology	Location	CT findings	WBC ($\times 10^3/\mu\text{L}$) (baseline*)	CRP (mg/L) (baseline*)	ESR (mm/h) (baseline*)	WBC ($\times 10^3/\mu\text{L}$) (last control*)	CRP (mg/L) (last control*)	ESR (mm/h) (last control*)	Gender and dose of antibiotic	Duration of iv antibiotic (hospitalization)
I	1	Male	Tonsillitis	Retropharyngeal	Abscess, long axis <20 mm	21	131	100	6,9	31	39	Penicillin $\times 200.000$ 3 IU+ Metronidazole 2 \times 150 mg	7
II	2	Female	Tonsillitis	Retropharyngeal	Soft tissue inflammation and pus-filled suppurative lymphadenitis, long axis <20 mm	14.5	51	39	7.5	13.1	8	Clindamycin 3 \times 100 mg	6
III	4	Male	Tonsillitis	Parapharyngeal	Abscess, long axis <20 mm	20	39	95	11.1	11.7	50	Penicillin 6 \times 300.000 IU+ Metronidazole 2 \times 250 mg	6
IV	6	Male	Tonsillitis	Parapharyngeal and retropharyngeal	Soft tissue inflammation and pus-filled suppurative lymphadenitis, long axis 13 mm	15.3	77	72	12	35	57	Ceftriaxone 2 \times 1 g+ Metronidazole 3 \times 250 mg	7
V	6	Male	Tonsillitis	Parapharyngeal	Abscess, long axis <20 mm	22.4	9	60	9.6	2.1	14	Penicillin 4 \times 200.000 IU+ Metronidazole 3 \times 250 mg	15
VI	6	Male	Tonsillitis	Parapharyngeal and retropharyngeal	Soft tissue inflammation and pus-filled suppurative lymphadenitis, long axis 25 mm	19.2	142	78	5.5	18	21	Ceftriaxone 2 \times 1 g+ Metronidazole 3 \times 250 mg	9
VII	6	Male	Other upper respiratory tract infection	Posterior cervical	Pus-filled suppurative lymphadenitis, long axis 22 mm	18.6	101	60	5.2	67	35	Clindamycin 3 \times 100 mg	6
VIII	7	Male	Dental caries	Parapharyngeal and Retropharyngeal	Abscess, long axis 21 mm	13.6	28	48	7.8	3	12	Penicillin 4 \times 200.000 IU+ Metronidazole 3 \times 150 mg	8
IX	7	Male	Tonsillitis	Parapharyngeal and retropharyngeal	Abscess, long axis <20 mm	17.9	147	96	6.3	41	60	Ceftriaxone 2 \times 1 g+ Metronidazole 3 \times 250 mg	5
X	17	Female	Tonsillitis	Parapharyngeal	Abscess, long axis <20 mm	10.6	189	95	8.9	101	52	Ceftriaxone 2 \times 1.5 g+ Metronidazole 4 \times 500 mg	5
XI	4	Male	Other upper respiratory tract infection	Parapharyngeal and retropharyngeal	Abscess, long axis 41 mm	18.3	190	70	9.3	75	32	Ceftriaxone 2 \times 0.6 g+ Metronidazole 2 \times 250 mg	7
XII	5	Male	Other upper respiratory tract infection	Parapharyngeal and retropharyngeal	Abscess, long axis <20 mm	25.2	93.9	65	7.9	11.6	44	Ceftriaxone 2 \times 1 g+ Metronidazole 3 \times 250 mg	5

*Baseline: The first day of hospitalization and parenteral treatment

*last control: The day before the discharge from hospital

 $\times 10^3/\mu\text{L}$: $\times 1000/\text{microliter}$

mg/L: milligram/liter; mm/h: millimeter/hour; mm: millimeter; DNI: deep neck infections CT: computed tomography; WBC: white blood cell; CRP: C reactive protein; ESR: erythrocyte sedimentation rate

plications related to DNI were noticed uncommon (6.7%) and primarily as readmissions to hospital for further iv antibiotic therapy (5).

Investigating the literature, it is not easy to find an absolute consensus that states the indications for surgery or conservation of childhood DNI. Kim et al. (10) suggested that being older than 7.5 years is a parameter related to medical therapy failure in a peritonsillar abscess. Kataria et al. (11) focused on radiological assessment and recommended surgery in the case of the suspicion of any abscess detected in ultrasound or CT. Cheng and Elden (5) presented their experience in 178 children with DNI. The authors advocated that if WBC count was more than 20,700/ μ L during admission, the diameter of the abscess was measured to be larger than 22 mm in neck CT, the age was less than 51 months, and there was a requirement for intensive care unit (ICU) due to the deterioration in general health status, medical therapy failure increased. Likewise, Bolton et al. (12) highlighted the negative effect of higher WBC count and younger age (<24 months) on complication rate and prolonged hospital stay. According to their data, non-ill-appearing and older patients who were not presented with respiratory problems in admission could be treated with medical therapy alone. Wong et al. (6) suggested that an abscess diameter larger than 25 mm as a risk factor for non-surgical treatment failure. As clearly understood from the views of the authors mentioned above, one of the criteria for making the decision for or against the medical care originated from radiological, particularly neck CT, outcomes. Regarding this topic, Saluja et al. (8) explained the indicators of abscess, cellulitis, and lymphadenitis in detail. According to the authors, absence of clear central hypodensity and ring enhancement referred to cellulitis whereas the opposite should be considered as an abscess. Freling et al. (13) determined a positive predictive value of 82% with contrast-enhanced neck CT and noticed that the most promising radiological aspect for abscess was air between facial plans or within the fluid with a negative predictive value of 100%. Ekşioğlu et al. (14) also highlighted the importance of using neck CT for the management of pediatric deep neck abscess based on its contributions to the ascertainment of complications. Some authors also utilized MRI for complementary diagnostic information (9, 15). Despite the fact that CT is responsible for an intense radiation exposure, the long duration and necessity of immobilization during the MRI process and the reductive fine tuning of the radiation dose when performing CT in children in our university limited the preference of MRI in our research. According to our results, most common locations of abscess were parapharyngeal and retropharyngeal spaces as compatible with the literature (9). The two largest sizes of the abscess were 21 (case VIII) and 41 mm (case XI) in two children, and none of the patients demonstrated an occupation of abscess or inflammation in more than two compartments. Besides, overall age was older than 4 years except for three cases. We claim that except for one child regarding his abscess size (case XI), all our results were compatible with the literature and that is why we did not see any treatment failure or requirement of surgery. However, case XI demonstrated a huge

abscess occupying two compartments which honestly perturbed us about the process. He was the latest case of this series what might be encouraged and prompted us to the medical management. We would probably carry out an immediate surgical intervention instead, if we were not as experienced in medical therapy alone in the management of pediatric deep neck abscess as current and not documented our success rate before his admission.

Recent reviews and review collections recommend medical therapy for deep neck abscess in the pediatric patient group (4). However, questions such as which antibiotic regimen to be used for the treatment, what to do in case of treatment failure, and how to prevent complications remain unsolved. Vieria et al. (16) suggested the use of empirical antibiotics for DNI which have adequate spectrum for both aerobic and anaerobic bacteria such as penicillin alone or combined with beta-lactamase agents, beta-lactamase--resistant drugs such as ceftriaxone, and antibiotics against anaerobic bacteria such as metronidazole and clindamycin. The complete achievement was obtained in a prospective study performed in seven pediatric deep neck abscess cases using amoxicillin and clavulanic acid combination by Sichel et al. (15). Lawrence and Bateman (2) determined the recommendation level of the utilization of these antibiotics mentioned above as grade C in their data collection but mostly because of the included reviews' low level of evidence. However, Poeschl et al. (17) reported high resistance rates with clindamycin (18% against aerobes and 11% against anaerobes). Resistance to metronidazole was 6% against anaerobes and resistance to penicillin was 7% and 8% against aerobes and anaerobes, respectively (17). The common etiological origin was odontogenic infections in the mentioned study (17). In our series, we did not observe any treatment failure with our antibiotic regimen. But except for the use of clindamycin alone, we always coupled drugs which had aerobic and anaerobic spectrum separately. We associate our high success rate of medical therapy with these combined regimens. On the other hand, specifically targeted antimicrobial agent for the result of pus and aspirate culture was also agreed (16). However, avoidance of any surgical intervention such as a needle aspiration prevented us from doing microbiological analysis and obligated the use of empirical broad-spectrum antibiotics. We remark the use of empirical regimens as the limitation of our study.

Although we did not experience, one of the most important question when choosing the medical therapy alone is what the next probable and unfavorable situation in the case of treatment failure will be and how to cope with it in pediatric deep neck abscess. Kataria et al. (11) offered an overall complication rate of 10% to 20% related to DNI. The most life-threatening complications and morbidities compromise respiratory collapse, jugular vein or cavernous sinus thrombosis, carotid artery ruptures, and mediastinitis. In pediatric group, life-threatening complications were found to be lower (2.2%) (5). Some authors introduced very high rates of medical treatment failure such as 49% (3) and 84.7% (9). Lee et al. (18) proposed that

odontogenic etiological origin lowered the complication rate, but particularly, if there was a spread of infection to more than two neck spaces, complications came in the front. Cheng et al. (5) suggested that especially due to the higher rates of methicillin-resistant *Staphylococcus aureus* in bacteriology, younger children (3, 4, and 8 months old) had more tendency to expose complications, but they did not find any correlation between immediate or delayed surgical drainage with the complication rate and prolonged hospital stay. The results of Wong et al. (6) did not specify a significant difference between conservative intervention or immediate surgical drainage regarding complications and hospitalization time. However, they indicated that high fever measured 24 or 48 h after the initiation of iv antibiotic therapy should alert the physician for a medical therapy failure (6). Similar opinions were offered by different authors too. Because of the increased frequency of mediastinitis in that group, Bolton et al. (12) paid extra attention to those pediatric patients whose WBC count were elevated and the age was less than 24 months. The rate of repeating CT was 21%, and they advised that if there was no improvement after 24-48 h from the initiation of antimicrobial agent in those patients described above, control neck CT combined with or without thorax CT was mandatory (12). A more recent and prospective study proved that on the contrary to the adult group, immediate or delayed surgical drainage had not effect on morbidity or mortality related to deep neck abscess in pediatric cases (19). In our clinical experience, close follow-up of the child's general status, fever, acute-phase reactants, WBC, and neck ultrasonography were used to monitor the improvement of the patient and the success of the medical therapy. Regarding this clinical feature, we did not recognize deterioration in our patient group which eliminated the necessity of any CT renewal, modification of antibiotics, or surgery.

In the contemporary study, it was demonstrated that deep neck space abscess and abscess containing suppurative lymphadenitis in children could easily be treated with intravenous medical therapy alone with a 100% success rate. We accept that our research has some limitations, regarding its retrospective nature, small sample size, and lack of statistical calculation targeted for analyzing potential risk factors or accurate prognostic parameters. However, our results correlated with previous literature in many aspects and additionally contributed some novel findings to the best of our knowledge. Selected cases that are presented with older age, inflammation occupying less than three neck spaces, a declining trend in acute-phase reactants (particularly WBC and CRP) are good candidates for medical treatment. In fact, we recommend an initial empirical parenteral medical therapy including agents effective for both aerobic and anaerobic microorganisms for all children diagnosed with deep neck abscess but monitor them closely for improvement in hospital. In our view, the microbial analysis is optional. Contrast-enhanced neck CT is an appropriate radiological diagnostic tool, especially when there is limited or painful neck movement, and neurological deficit, to decide on the right treatment alternative. Fever monitoring plays a significant role in the clinical follow-up course. Increasing temperature, increasing or non-decreasing

acute-phase reactants, worsening neck's range of motion and mouth openness, decreasing oral intake, and deterioration in general health status 24 to 48 h after the beginning of the antibiotic should alert for medical treatment failure and make the otolaryngologist consider other treatment and intervention alternatives.

Conclusion

Consequently, according to our results, we recommend medical treatment alone with empirical intravenous combined or broad-spectrum antibiotic regimen in childhood deep neck abscess, independent of age, if the baseline WBC is $\leq 25.200/\mu\text{L}$, only two or lesser cervical compartments are involved, if there are none of the complications in admission, and if the etiology is not based on a previous surgery, trauma, foreign body, and malignancy. Regarding our results, except for one case (case XII, 41 mm), the long axis of the abscess with a < 25 -mm length is also considered to be a good prognostic indicator for medical treatment, as previously mentioned. On the other hand, our results contribute a novel concept to literature that greater abscess size is not a limitation for the medical therapy preference. We propose that the most important point is close monitoring of the children with observing the general status, symptoms, physical examination findings, and laboratory assays. Instead of immediate surgical drainage methods, we suggest a conservative medical therapy as an entirely satisfactory treatment option for selected cases of pediatric deep neck abscess.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Dokuz Eylül University Non-Observational Researchs Review Board (2016/08-29, protocol number of 2599-GAO).

Informed Consent: Informed consent was not received due to the retrospective nature of the study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - T.K.E., A.Ç.Ç., Y.O., A.Ö.; Design - A.Ç.Ç., Y.O., T.K.E., A.Ö.; Supervision - T.K.E., A.Ç.Ç., A.Ö., Y.O.; Resource - A.Ö., A.Ç., Y.O., T.K.E.; Materials - A.Ç.Ç., A.Ö., Y.O., T.K.E.; Data Collection and/or Processing - A.Ç.Ç., A.Ö., Y.O., T.K.E.; Analysis and/or Interpretation - A.Ç.Ç., Y.O., A.Ö., T.K.E.; Literature Search - A.Ç.Ç., T.K.E., A.Ö., Y.O.; Writing - A.Ç.Ç., T.K.E., Y.O., A.Ö.; Critical Reviews - T.K.E., A.Ç.Ç., Y.O., A.Ö.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

References

1. Erdağ TK. Derin Boyun Enfeksiyonu. In: Karaböcüoğlu M, Yılmaz HL, Duman M, editors. Çocuk Acil Tıp Kapsamlı ve Kolay Yaklaşım. Cilt II. 1. ed. İstanbul: İstanbul Tıp Kitabevi; 2012. p. 2063-76.
2. Lawrence R, Bateman N. Controversies in the management of deep neck space infection in children: an evidence-based review. Clin Otolaryngol 2017; 42: 156-63. [CrossRef]

3. Nagy M, Pizzuto M, Backstrom J, Brodsky L. Deep neck infections in children: a new approach to diagnosis and treatment. *Laryngoscope* 1997; 107: 1627-34. [\[CrossRef\]](#)
4. Carbone PN, Capra GG, Brigger MT. Antibiotic therapy for pediatric deep neck abscesses: a systematic review. *Int J Pediatr Otorhinolaryngol* 2012; 76: 1647-53. [\[CrossRef\]](#)
5. Cheng J, Elden L. Children with deep space neck infections: our experience with 178 children. *Otolaryngol Head Neck Surg* 2013; 148: 1037-42. [\[CrossRef\]](#)
6. Wong DK, Brown C, Mills N, Spielmann P, Neeff M. To drain or not to drain - management of pediatric deep neck abscesses: a case-control study. *Int J Pediatr Otorhinolaryngol* 2012; 76: 1810-3. [\[CrossRef\]](#)
7. Kaya EE, Taşar MA, Dallar Bilge Y. Evaluation of deep neck infections in pediatric patients. *Turkish J Pediatr Dis* 2012; 6: 197-205.
8. Saluja S, Brietzke SE, Egan KK, Klavon S, Robson CD, Waltzman ML, et al. A prospective study of 113 deep neck infections managed using a clinical practice guideline. *Laryngoscope* 2013; 123: 3211-8. [\[CrossRef\]](#)
9. Yang W, Hu L, Wang Z, Nie G, Li X, Lin D, et al. Deep neck infection: A review of 130 cases in Southern China. *Medicine (Baltimore)* 2015; 94: e994. [\[CrossRef\]](#)
10. Kim DK, Lee JW, Na YS, Kim MJ, Lee JH, Park CH. Clinical factor for successful nonsurgical treatment of pediatric peritonsillar abscess. *Laryngoscope* 2015; 125: 2608-11. [\[CrossRef\]](#)
11. Kataria G, Saxena A, Bhagat S, Singh B, Kaur M, Kaur G. Deep neck space infections: A Study of 76 cases. *Iran J Otorhinolaryngol* 2015; 27: 293-9.
12. Bolton M, Wang W, Hahn A, Ramilo O, Mejias A, Jaggi P. Predictors for successful treatment of pediatric deep neck infections using antimicrobials alone. *Pediatr Infect Dis J* 2013; 32: 1034-6. [\[CrossRef\]](#)
13. Freling N, Roele E, Schaefer-Prokop C, Fokkens W. Prediction of deep neck abscesses by contrast-enhanced computerized tomography in 76 clinically suspect consecutive patients. *Laryngoscope* 2009; 119: 1745-52. [\[CrossRef\]](#)
14. Ekşioğlu AS, Timur ÖM. Computed tomography findings in deep neck infections in children. *Medical Bulletin of Haseki* 2014; 52: 34-8. [\[CrossRef\]](#)
15. Sichel JY, Dano I, Hocwald E, Biron A, Eliashar R. Nonsurgical management of parapharyngeal space infections: a prospective study. *Laryngoscope* 2002; 112: 906-10. [\[CrossRef\]](#)
16. Vieira F, Allen SM, Stocks RM, Thompson JW. Deep neck infection. *Otolaryngol Clin North Am* 2008; 41: 459-83. [\[CrossRef\]](#)
17. Poeschl PW, Spusta L, Russmueller G, Seemann R, Hirschl A, Poeschl E, et al. Antibiotic susceptibility and resistance of the odontogenic microbiological spectrum and its clinical impact on severe deep space head and neck infections. *Oral surgery, oral medicine, oral pathology, oral radiology, and endodontics*. 2010; 110: 151-6. [\[CrossRef\]](#)
18. Lee JK, Kim HD, Lim SC. Predisposing factors of complicated deep neck infection: an analysis of 158 cases. *Yonsei Med J* 2007; 48: 55-62. [\[CrossRef\]](#)
19. Cramer JD, Purkey MR, Smith SS, Schroeder JW, Jr. The impact of delayed surgical drainage of deep neck abscesses in adult and pediatric populations. *Laryngoscope* 2016; 126: 1753-60. [\[CrossRef\]](#)