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Evaluation of the conservative management of acute neck infections in children during COVID-19 pandemic

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Abstract
Background: Acute neck infection in children is a relatively common presentation to otolaryngologists in emergency setting that always requires prompt intervention to avoid life-threatening complications. The aim of the study was to evaluate the conservative management strategy for management of paediatric neck infection we adopted during the COVID-19 pandemic.
Methods: This Prospective study that was carried out on 34 Patients aged from 1 to 12 years old presented with acute neck infection that was not amenable or did not respond to simple oral outpatient treatment. Patient were categorized into conservative group received IV medical treatment for 48 hours. The Aspiration group had neck Ultrasound (US) guided aspiration of the residual collection after medical treatment. The Incision& Drainage group in which medical treatment and ultrasound guided aspiration were insufficient.
Results: More than half of our patients (53%) were successfully managed in a conservative way. Other patients (29%) were treated with minimally invasive fashion in the firm of US guided aspiration, and the remaining patients (18%) underwent Incision and drainage under general anaesthesia. There was significant reduction in total leukocyte count (TLC) and C-reactive protein (CRP) after 48 hrs of medical treatment in the different groups. We can't rely on the value of TLC or CRP as cut-off point to determine the presence of drainable collection or not. But it can be used as follow up marker.
Conclusions: In a stable patient with acute neck infections, intravenous antibiotic treatment with corticosteroids is a good and safe alternative to surgical drainage. Ultrasonography is of good value in evaluating non complicated cases of acute neck infection.

Keywords: Conservative management, acute neck infections, COVID-19 pandemic

Introduction
Neck infection in children is a relatively common presentation to Otolaryngologists in emergency setting that always requires prompt intervention to avoid life-threatening complications. It has been recognized that neck infections in children have a unique natural history when compared to adults. The microbiology pathogenesis and the response to initial medical treatment have been highlighted as the major differences between neck infections in pediatric and adult populations [1, 2].
Comprehensive history taking, physical examinations and laboratory investigations are crucial to diagnose neck infection in children. However, neck radiology, including neck ultrasound and cross-sectional imaging, have been considered essential for formulating treatment plans and road mapping potential surgical interventions [3].
Treatment of pediatric neck infection can include a wide array of choices from out-patient oral medication to invasive airway establishment and surgical drainage according to the initial presentation, clinical and radiological findings [4].
With the new public health crisis threatening the world represented by the emergence and spread of the COVID-19 strain of coronavirus, most of the health systems were adopting precautionary strategies to minimize admission, presence and elective surgical interventions to non-COVID-19 positive population. Expectedly, children safeguarding and minimizing their involvement in the hospital environment is a priority in these times.

Also there have been many concerns and regulations regarding exposure of children to the high dose X-ray radiation, unless indicated, with the evolving evidence about the long-term effect of ionized radiation including potential carcinogenesis [5, 6].

Recent studies show that in select cases, an uncomplicated neck infection presented with cellulitis or small collection can be effectively treated with antibiotics and careful monitoring, without surgical drainage. The use of steroids along with antibiotic treatment may reduce the need for surgical intervention by minimizing airway edema, inflammation, and the progression of cellulitis into an abscess [7, 8]. Minimally invasive techniques using ultrasound guidance is appropriate for locating and draining abscesses accessible through the skin. Needle aspiration and catheter placement offer the advantages of a small point of entry, quick healing time, little or no scar formation, and less risk of contaminating the surrounding deep neck spaces while draining pus [9].

Conservative treatment strategies of neck infections in children with the associated decreased visits to radiology suits, shortened hospital stay and adopting minimally invasive surgical drainage can't be more relevant as in COVID-19 era when all efforts and regulations encouraged to slow down the spread by minimizing exposure of non-COVID-19 population to the high-risk environments with hospitals are on the top of the list [10].

The aim of this work was to evaluate the conservative management strategy for management of paediatric neck infection we adopted during the COVID-19 pandemic.

Patients and Methods

This was a prospective study carried out on 34 patients aged from 1 to 12 years old presented with acute neck infection with no amenable or did not respond to simple oral outpatient treatment in Otolaryngology – Head and Neck Surgery Department - Tanta University Hospitals, in the duration between October 2020 to June 2022.

An informed written consent was obtained from the patient or their relatives. The study was done after approval from the Ethical Committee Tanta University Hospitals.

Exclusion criteria were patients under one year of age, patients presented with severe life-threatening complications including airway obstruction, septicaemia or aspiration pneumonia requiring immediate intervention, airway establishment or ICU admission, patient with suspected peri-tonsillar or para-pharyngeal collection at presentation and immunocompromised patients.

Patients were categorized according to the managements into 3 pathways: conservative group included 18 children and received IV medical treatment only for 48 hours. The Aspiration group included 10 children and had neck Ultrasound (US) guided aspiration of the residual collection after medical treatment. The Incision& Drainage group included 6 children in whom medical treatment and ultrasound guided aspiration were insufficient.

All patients were subjected to 1-History taking. 2-General Examination: initial evaluation was focused on signs indicating the need for resuscitation / critical care. Vitally stable patients had initial clinical evaluation of airway patency, breathing difficulty, heart rate, hydration status and body temperature. 3-Local examination: routine head and neck examination. Airway examination was specially focused on signs of airway edema, floor of mouth swelling and shift of the laryngeal air column. Oral and dental examination was carried out to report dental infection or intra-oral swellings. Neck was examined for asymmetries, swellings, skin discoloration or discharging incisions / sinuses. 4-Laboratory investigations: Complete blood count (CBC), C-reactive protein (CRP) and Bleeding / coagulation profile. 5-Management protocol: All patients meeting the inclusion criteria were admitted to inpatient ward, received initial empirical intravenous medical treatment in the form of: a) Ampicillin/ sulbactam with maximum dose 100-200 mg/kg/day ampicillin divided every 8 hrs. b) Metronidazole 22.5 to 40 mg/kg/day divided every 8hrs. c) Antipyretic / analgesics (Paracetamol 15mg/kg/dose). d) Rapid acting corticosteroids 0.2 to 0.3 mg/kg/day divided every 12 hrs (Dexamethasone).

The cause of the acute neck infection was managed when present like treatment of dental infection or skin lesion like impetigo. All patients were evaluated 48h after start of medical treatment with clinical examinations, CBC, CRP, and US examination. The machine used was SonoScape E1Exp using linear probe L743 with superficial parts setting, (SonoScape Medical Corp, Shenzhen, China).

Patients with clinical improvement (fever improved, swelling decreased in size, patients returned to full oral feeding) who had declined inflammatory markers with no drainable collection by US examination, were discharged home on simple oral treatment amoxicillin- Clavulanic acid, antipyretic /analgesic for at least 10 days (Conservative Group).

Patients with residual swelling after the initial treatment with US examination showing residual collection, US guided aspiration was done under IV sedation whenever possible or with mask inhalation with continuation of IV medical treatment for another 48 hrs. (Aspiration Group).

Patients who did not improve with IV medical treatment with failed US guided aspiration or did not improve after aspiration were reassessed with CT scan with IV contrast if necessary and had conventional Incision and drainage under general anaesthesia (I & D group).

Statistical analysis

Analyses were performed using SPSS version 21. Non-Parametric quantitative data were presented by Mean ± SD, range, median, IQR and evaluated by Kruskal Wallis test (in case of more than 2 independent groups) and Wilcoxon signed ranks test (in case of 2 dependent paired measures). Categorical data were presented by number and percent and assessed by the Monte Carlo Exact. The P value was considered significant at the level of < 0.05.

Results

No significant difference was found between the three groups regarding age or gender. Table 1

Table 1: Demographic data of participants in the three pathways of management

Variables	Management			Total (n = 34)	p
	Conservative (n =18)	Aspiration UGA (n = 10)	I & D UGA (n = 6)		
Age (Mean ± SD)					
	7.3 ± 3.20	5.0 ± 3.99	4.6 ± 4.18	6.1 ± 3.72	0.130
Sex					
Male	10 (55.6%)	5 (50.0%)	4 (66.7%)	19 (55.9%)	0.902
Female	8 (44.4%)	5 (50.0%)	2 (33.3%)	15 (44.1%)	

SD: Standard deviation; I & D UGA: incision and drainage under general anesthesia; data was presented in Mean ± SD

There was no significant difference in distribution of deep neck space lesion between three groups. The most common cause of acute neck infection in all lines of management was unknown then dental cause and four cases following impetigo. Total Leukocyte Count (TLC) and CRP was lower in all groups of management than at diagnosis After 48 hours of IV antibiotic. Table 2

Table 2: Distribution of lesion, aetiology, TLC & CRP pre, TLC & CRP after 48 hours of IV antibiotic between participants in the three lines of management.

	Management			Total (n = 34)	P
	Conservative (n =18)	Aspiration UGA (n = 10)	I & D UGA (n = 6)		
Lesions					
right submandibular infection	6 (33.3%)	4 (40.0%)	2 (33.3%)	12 (35.3%)	0.311
left submandibular infection	6 (33.3%)	2 (20.0%)	2 (33.3%)	10 (29.4%)	
Submental infection	2 (11.1%)	1 (10.0%)	1 (16.7%)	4 (11.8%)	
Submental and bilateral Submandibular infection	3 (16.7%)	0 (0.0%)	0 (0.0%)	3 (8.8%)	
right sub masseteric infection	1 (5.6%)	0 (0.0%)	0 (0.0%)	1 (2.9%)	
left submental and submandibular infection	0 (0.0%)	0 (0.0%)	1 (16.7%)	1 (2.9%)	
Posterior triangle infection	0 (0.0%)	2 (20.0%)0	0 (0.0%)	2 (5.9%)	
left buccal infection	0	1	0	1	
Etiology					
Unknown etiology	7 (38.9%)	8 (80.0%)	5(83.3%)	20(58.8%)	0.095
Dental	8 (44.4%)	2 (20.0%)	0 (0.0%)	10(29.4%)	
Impetigo	3 (16.7%)	0 (0.0%)	1(16.7%)	4(11.8%)	
TLC pre	13230.6 ± 4155.90	14887.0 ± 2809.77	15416.7 ± 3848.33	14103.5±3769.57	0.286
CRP pre	96.9 ± 98.42	47.1 ± 47.28	70.6 ± 64.63	77.6 ± 82.03	0.716
TLC post	8850.0 ± 2643.81	9678.0 ± 3686.43	11566.7 ± 2450.85	9572.9 ± 3037.81	0.070
CRP post	19.3 ± 21.76	13.9 ± 18.05	14.8 ± 11.53	16.9 ± 18.95	0.385

I & D UGA: incision and drainage under general anaesthesia; SD: Standard deviation; CRP: C-reactive protein; TLC: Total Leukocyte Count

There was significant difference between TLC and CRP At diagnosis and After 48 hours of IV antibiotic in conservative and Aspiration group. TLC was significantly reduced after 48 hours of IV antibiotic than at diagnosis with no significant difference regarding CRP in I&D group. Table 3

Table 3: TLC & CRP pre & post in conservative, Aspiration UGA, I & D (UGA) management

Variables	Pre	Post	P
Conservative			
TLC	13230.6 ± 4155.90	8850.0 ± 2643.81	<0.001*
CRP	96.9 ± 98.42	19.3 ± 21.76	0.001*
Aspiration UGA			
TLC	14887.0 ± 2809.77	9678.0 ± 3686.43	0.005*
CRP	47.1 ± 47.28	13.9 ± 18.05	0.005*
I & D UGA			
TLC	15416.7 ± 3848.33	11566.7 ± 2450.85	0.028*
CRP	70.6 ± 64.63	14.8 ± 11.53	0.080

*$p < 0.05$ (Statistically significant); SD: standard deviation; I & D UGA: incision and drainage under general anesthesia. TLC: total leucocytic count, CRP: C reactive protein.

Discussion

In this study, acute neck infections were more frequent in younger children, especially in those who were 6 years old or younger.

The patients in this study were mainly males. This male gender predominance is also reported in the literature, with the underlying reasons being unknown and this was similar to what was found in the study by Demongeot *et al*. on pediatric acute neck infections [11].

The anatomic spaces deep to the superficial layer of deep cervical fascia of the neck can be divided into those above the hyoid bone, those below it, and those that involve the entire length of the neck. The spaces above the hyoid bone include the peritonsillar, submandibular, parapharyngeal, masticator, buccal, and parotid spaces. The deep neck spaces below the hyoid bone include the anterior visceral/pretracheal space. Finally, the spaces that involve the whole length of the neck include the retropharyngeal, danger, prevertebral, and carotid spaces [12]. Regarding the distribution of lesions between participants in the three lines of management in this study the submandibular space was the most affected across all groups. This was the same with Maharaj *et al*, who also reported that the submandibular space was the most commonly affected across all age groups in their study [13].

In this study we found that the most common cause of acute neck infection in all lines of management was unknown in 20 cases (58.8%) then dental cause was evident in 10 (29.4%) and four cases following impetigo. This was similar

to what was found by Yang W *et al*, who reported that the cause was unknown in their study of neck infection [14].

In the present study which was carried out in the era of COVID-19, we aimed to limit patient movement between different hospital services and exposure to inhalation general anesthesia to minimize risks of COVID-19 transmission during hospital stay. In the first 48 hrs, our patient population were not referred to any radiological assessment. Then reassessment was done by laboratory follow up and inpatient bed-side US offered in our department by clinicians this was exploiting the benefits of ultrasound, including avoiding radiation exposure and decreased imaging costs, decreased visits to radiology suits where many patients with suspected COVID-19 infection being examined by contrast enhanced computed tomography (CECT) chest to evaluate their chest condition which carry risk of transmission of COVID-19 infection to non-COVID-19 population. We reserved CECT neck for more select indications. If the infection were high in the neck or a clinician suspected parapharyngeal or retropharyngeal extension, CECT would be preferred. In our study we used CECT neck as the last step for the management of acute neck infections before doing incision and drainage for the cases in whom medical therapy and US guided aspiration had failed.

This comes in align with the American College of Radiology which had developed appropriateness criteria for specific imaging studies in various clinical conditions. These criteria are scored from 1 to 9. A score of 1–3 represents a "usually not appropriate" study for that situation, while a score of 7–9 represents a "usually appropriate" indication. Ultrasound has an appropriateness criteria score of 9 and CECT has a score of 8 for a child under 14 years of age with a fever and a palpable neck mass [15].

In this study, only 6 patients (18%) had CECT. Neck US wasn't used initially but at least 48 hrs after admission for follow up and or aspiration guidance. Around 47% of our study population were managed to cure using US guidance only.

Surgical drainage with intravenous antibiotic treatment was the traditional mainstay of management of pediatric acute neck infections, but more recently numerous investigators have advocated a more conservative approach [16-22].

Due to this, some authors [22, 23] advocate intravenous antibiotic alone and surgery reserved for those who did not improve after several days or developed complications.

In this study which included 34 children all patients underwent initial conservative management in the form of parenteral antibiotics and corticosteroid in the first 48 hrs, 18 of them (53%) were successfully managed with a conservative strategy. In 16 (47%) patients whom clinical symptoms did not improve completely after 48 hrs, these patients were reevaluated by repeated US examination and repeated TLC and CRP. Ten patients in whom collection of pus and persistent elevation of TLC and CRP were found (29%), were successfully treated with minimally invasive techniques in the form of US guided aspiration. The remaining 6 patients who did not improve with IV medical treatment with failed US guided aspiration or did not improve after aspiration were reassessed with CECT and eventually underwent delayed surgical drainage in the of conventional Incision and drainage under general anesthesia with 1 patient developed temporary marginal mandibular nerve weakness after incision and drainage of submandibular space infection.

In this study we used the minimally invasive techniques in the form of US guided aspiration as a second line management before the classical external incision and drainage for the 16 children (47%) who didn't improve on IV antibiotics and corticosteroid. And it showed success in 10 cases (29%). Our strategy was to achieve the advantages of a small point of entry, quick healing time, little or no scar formation, and less risk of contaminating the surrounding deep neck spaces while draining pus.

In the present study we added corticosteroid in the form of rapidly acting Dexamethasone along with IV antibiotic at the first 48h as conservative treatment and it showed success in more than half of the cases which were successfully managed without surgery. None of our patients had any reported side effect of steroid treatment. So, we recommend the use of corticosteroid along with IV antibiotics as a first line treatment for the uncomplicated acute neck infections in children.

This comes in agreement with A study by Mayor and colleagues [7] who found that conservative treatment does not increase mortality or length of hospitalization in diagnosing neck infection (DNI). The use of steroids along with antibiotic treatment may reduce the need for surgical intervention by minimizing airway edema, inflammation, and the progression of cellulitis into an abscess [7].

In this study patients were evaluated the patients clinically (fever, odynophagia, neck swelling, preceding dental infection, impetigo or URTI) and with the inflammatory markers TLC and CRP which were recorded at admission and 2 days after the onset of the conservative treatment. Total leukocytic count and CRP were high of all patients at presentation as mean TLC in total was (13230.6 ± 4155.90 /μL) and mean CRP in total was 77.6 ± 82.03 mg/dL. After 48 hours of IV antibiotic, TLC was lower in all lines of management than at diagnosis with mean TLC after 48 hours of IV antibiotic was (8850.0 ± 2643.81 /μL). Also, after 48 hours of IV antibiotic, CRP was lower in all lines of management than at diagnosis with mean CRP after 48 hours of IV antibiotic was 16.9 ± 18.95 mg/dL.

There was significant difference in TLC a at time of admission and that in TLC after 48 h of start of medical treatment in all pathways of management groups being significantly decreased. Also, there was significant reduction of CRP levels before and 48h after medical treatment in the conservative and aspiration groups. In the group who underwent final I and D there was reduction of CRP levels before and after treatment but without significance.

So, upon the previous analysis there is no cut-off value of TLC or CRP as definite value to determine the presence of drainable collection or not. But it can be used as follow up to determine the efficacy of the management protocol in all cases as both TLC and CRP decreased after 48h of medical treatment and reached their normal values at discharge.

Conclusions

Acute neck infection represents dangerous entities with very serious potential complications. In a stable patient, intravenous antibiotic treatment with corticosteroids is a good and safe alternative to surgical drainage. Despite our good results, each case must be analyzed, alarm symptoms (airway compromise, lack of response to antibiotic therapy)

should be monitored. TLC and CRP are of good value to follow up efficacy of medical treatment. Ultrasonography is of good value in evaluating non complicated cases of acute neck infection.

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