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Original Article

Paediatric Deep Neck Space Abscesses: Experience of a Tertiary Care Hospital

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Abstract To evaluate children diagnosed with deep neck space abscesses (DNSAs) between January 2011 and January 2020, a retrospective chart review was performed. Demographics, clinical manifestations, laboratory and radiological investigations, antibiotic choice, need for surgery, operative reports, length of hospital stay and prognosis were recorded. Sixty-two patients were enrolled. The most common presentation was fever and the most common location was parapharyngeal abscess. Patients who were surgically treated had larger abscess diameters on contrast-enhanced computed tomography compared to those who received conservative treatment (p: 0.025) but we did not find any difference in laboratory data, antibiotic duration and length of hospital stay. Surgical treatment was more common in patients aged 0-5 years compared with those >5 years (p<0.001). Although there is still a lack of consensus on the optimal management or timing for surgery, conservative treatment with close follow-up can be successfully applied in selected cases.

Key words *Children; Deep neck space abscess; Surgery*

Introduction

Deep neck space abscesses (DNSAs) are defined as infection in the potential spaces and fascial planes of the neck.[1] Although they remain rare in children in the antibiotic era, an increase in incidence has nevertheless been seen.[2,3] Based on the anatomical sites of infection, DNSAs can be categorised as retropharyngeal, parapharyngeal, peritonsillar, submandibular, mixed type, and other abscesses.[4] They may occur in distinct spaces in different age groups. Retropharyngeal and parapharyngeal abscesses are more common in early childhood, with a peak between the ages of 2 and 5 years, because there is regression in the lymph nodes by age. Peritonsillar abscesses usually occur due to the spread of the infection from acute tonsillitis, so they are primarily seen in older children and adolescents.[5] Deep neck space abscesses often present with nonspecific symptoms such as upper respiratory tract infection, fever, decreased oral intake, neck pain, swelling of the cervical lymph nodes, limitations of neck range of motion, or trismus, which makes the diagnosis difficult; accurate diagnosis remains a challenge to paediatricians because of insidious signs.[6-8] They are associated with life-threatening complications including airway obstruction, mediastinitis, jugular vein thrombosis, cranial nerve dysfunction, and sepsis/septic shock, leading to potential morbidity and mortality.[9,10] Because DNSAs show rapid onset and cause serious

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complications when neglected, early diagnosis and adequate management are crucial. The diagnosis is based on clinical evaluation and radiological imaging modalities such as ultrasonography (US), contrast-enhanced computed tomography (CECT), or magnetic resonance imaging (MRI).[11] Although CECT has become the most accurate and widely used imaging technique, there are still controversies about its diagnostic value and utility in assessment of DNSAs.[12] The mainstay of treatment is antibiotics and surgical drainage, if required. There is still a lack of consensus on the optimal management of paediatric DNSAs. Some authors advocate immediate surgical drainage because of shorter hospital stay, false negative radiological findings, and the possible rapid spread and life-threatening consequences. In contrast, recent studies support the use of conservative approaches alone if there is no evidence of failure to clinically improve with antibiotic treatment or if there is a complicated clinical course that includes airway compromise or multiple sites of abscesses.[9,13-15] Wong et al reported that patients with smaller abscess size (maximal diameter less than 25 mm) or younger age could be successfully managed conservatively as first-line treatment.[9] In another study, it was reported that smaller abscess size could predict favourable outcomes of conservative treatment of peritonsillar abscesses.[16] There is also a debate on the timing of the surgical approach. It is unknown whether delaying surgical drainage has a relatively negative effect on outcomes.[17]

The aim of the present study was to evaluate the demographic data, clinical features, laboratory and radiological characteristics, management, and outcomes of children diagnosed with DNSAs in order to identify predictors of need for surgery and prognosis in a tertiary level hospital.

Materials and Methods

Study Design

This was a single-centre retrospective chart review performed in the paediatric emergency department of the Dokuz Eylul University Faculty of Medicine, a tertiary level hospital. The study was approved by the Institutional Review Board of the Dokuz Eylul University Faculty of Medicine.

Children aged 0 to 18 years who were referred to the paediatric emergency department and diagnosed with DNSAs between January 2011 and January 2020 were included. We used the International Classification of Diseases (ICD) codes for DNSAs to identify patients. We obtained information from the computer database, electronic medical records, medical charts, and nursing records. Patients with superficial infections, phlegmon/cellulitis, lymphadenitis, infections due to trauma, foreign body or surgery, immuncompromise, tuberculosis, congenital cervical anomalies, thyroid gland infections, malignancies, and insufficient data were excluded. All data were investigated and recorded by a paediatric emergency fellow and two paediatric residents.

The following data were also obtained: demographics; duration of symptoms and antibiotic use before arrival at the emergency department; clinical manifestations; laboratory data including blood cultures, white blood cell (WBC) count, absolute neutrophil count (ANC), erythrocyte sedimentation rate (ESR), and serum C-reactive protein (CRP) levels; the radiological imaging technique preferred; US, CT, or MRI findings; and the maximal diameter of the abscess formation. The site of infection was categorised into 5 groups as follows: parapharyngeal, retropharyngeal, peritonsillar, submandibular, and mixed type of abscesses.[4] Abscess was defined as the presence of a hypolucent or hypointense mass with complete or near-total rim enhancement.[18] Abscess formation in the space surrounded by the palatine tonsils, limited externally by the superior pharyngeal constrictor muscle, was defined as peritonsillar abscess. Parapharyngeal abscess is localised medially to the space surrounded by the pharynx, the carotid sheath posteriorly, and the muscles of styloid process laterally. Retropharyngeal abscess is confined posteriorly to the pharynx, bounded by the buccopharyngeal fascia anteriorly, the prevertebral fascia posteriorly, and the carotid sheaths laterally. Submandibular abscess is bounded by a superficial layer of deep cervical fascia inferiorly and by the lingual mucosa superiorly. If there were two or more compartments of infection, it was defined as the mixed type of abscess.[4,7] The determination of the location of DNSAs was based on clinical manifestations and/or radiological investigations. Antibiotic choice, the duration of antibiotic treatment, need for surgery, operative reports, and, if obtained, pus culture specimens were recorded. Subjects were divided into three groups according to treatment approaches: immediate surgical drainage, delayed surgical drainage, or treatment with antibiotics alone. Delayed surgical drainage was defined as a time interval to surgery of more than 24 hours from the start of first intravenous antibiotic treatment

or failure of medical therapy.[17] The following were investigated as complications of DNSAs: airway obstruction, jugular vein thrombosis, mediastinitis, emphysema, pericarditis, cranial nerve dysfunction, and sepsis/septic shock.[9,10] Recurrence was defined as the reappearance of the infection after one month of clinical remission.[19] Finally, the need for admission to the ward or PICU, total length of stay in the hospital, prognosis, and mortality were recorded. During the study period, there was no standardised protocol for the management of DNSA patients; the decision for surgical intervention was reserved for the judgement of individual surgeons.

Statistical Analysis

All statistical analyses were performed using SPSS 22.0 for Windows. Categorical and continuous variables were reported as frequencies and percentiles, means with standard deviations (SD), or medians with interquartile ranges (IQRs). The Mann-Whitney U test was used to compare non-parametric variables and Student's t test was used for parametric data. Correlations were assessed with Spearman's rank correlation coefficient. To determine the cut-off diameter of abscesses to predict surgical intervention, receiver operating characteristic (ROC) curve analysis was performed and sensitivity and specificity were calculated. Values of $p<0.05$ were considered statistically significant.

Results

Study Population

A total of 62 patients were enrolled during the study period. The median age was 6.0 years (IQR: 3.0-10.0). Seventeen patients (27.4%) were under five years of age. Of the patients, 35 (56.5%) were male and 27 (43.5%) were female (Table 1). The most common presentations were fever, sore throat, limitations of neck range of motion, neck swelling, and dysphagia. Frequencies of all signs and symptoms are shown in Table 2. At the time of admission, 40 patients (64.5%) presented with ongoing upper respiratory tract infection, with symptoms having started a median of 4.0 days earlier (IQR: 4.0-7.0), and 26 (41.9%) patients had received enteral or parenteral antibiotic treatment 4.4±2.3 days prior to the referral. The most often prescribed antibiotic was amoxicillin clavulanate (57.7%), followed by ceftriaxone (15.4%), ampicillin sulbactam (11.6%), clindamycin (7.7%), gentamicin (3.8%), and cefdinir (3.8%). Patients had an initial mean WBC count of 20200±9200/mm^3, ANC of 15300±8200/mm^3, ESR level of 59.4±28.4 mm/h, and CRP value of 107.5±79.4 mg/L, which were consistently increased and showed a status of inflammation (Table 1). Blood cultures were obtained from 21 (33.9%) patients and, of those, only one was positive (mixed type of bacteria). Pus specimens were obtained from 26 (41.9%) patients and 10 (38.5%) of them resulted in positive cultures. Of the 10 positive specimens, the most common microorganisms were *Streptococcus pyogenes* (40.0%) followed by *Streptococcus viridans* (10.0%), *Streptococcus parasanguinis* (10.0%), coagulase-negative Staphylococcus (10.0%), Haemophilus influenzae (10.0%), gram-negative Bacillus (10.0%), and anaerobic bacteria (10.0%).

Radiology

Ultrasound was performed for 14 (22.6%) patients and CECT for 52 (83.9%). Thirteen (20.9%) patients were evaluated with both US and CECT together. The most common abscess location was parapharyngeal (n: 23, 37.1%), followed by peritonsillar (n: 17, 27.4%), submandibular (n: 9, 14.5%), mixed (n: 7, 11.3%), and retropharyngeal space (n: 6, 9.7%) (Table 1). Peritonsillar abscess was more common in patients aged >5 years (n: 16, 35.5%) than 0-5 years (n: 2, 11.7%) ($p<0.001$). In 13 (20.9%) cases, repeated radiological images were obtained in order to evaluate response to treatment or to guide the surgical planning for the patients. Of those, 9 (69.2%) were repeated with US, 3 (23.0%) with CECT, and one (7.7%) with MRI.

Management

Of the patients, 29 (46.8%) were treated with antibiotics alone and 33 (53.2%) underwent surgery with antibiotic treatment. Of the 33 undergoing surgery, 3 (9.1%) underwent immediate and 30 (90.9%) underwent delayed surgery. The most preferred antibiotics were clindamycin alone (n: 38, 61.2%), a combination of ampicillin sulbactam + clindamycin (n: 14, 22.7%), and a combination of ceftriaxone + clindamycin (n: 10, 16.1%). Among the 33 patients who were surgically treated, 24 (38.7%) of them underwent a transoral approach and 9 (14.5%) had open surgery with drainage of the abscess through cervicotomy. The overall time interval between admission and surgery was a median of 2.0 days (IQR: 0.0-12.0). Closed drainage was classified as a surgical treatment and was performed by surgeons in our study. Evaluating patients who underwent surgical treatment, we

compared closed versus open drainage but there was no difference in age (p: 0.077), duration of antibiotic therapy (p: 0.090) and, total length of stay in the hospital (p: 0.849). There was a change in treatment strategy for 4 patients (6.4%) in the study; all but one of them underwent surgery. The first antibiotic which was started for these 4 patients was clindamycin. One patient, who was a 2.5-year-old boy with a parapharyngeal abscess of 2.5 cm on CECT, was successfully treated with a change in antibiotics as being ceftriaxone 48 hours after admission. Among 3 patients who underwent surgery, the first case was a 6-year-old boy with a 2 cm of parapharyngeal abscess on CECT who underwent surgery on the 5th day of admission. The second patient was a 2-year-old girl with a 3.5 cm of submandibular abscess and she underwent surgery on the 7th day of admission. The third patient was

Table 1 Demographics, laboratory/radiological features, and management of the patients in the study

Variable	n: 62
Sex (n, %)	
Male	35 (56.5%)
Female	27 (43.5%)
Age in years [median (IQR)]	6. 0 (3.0-10.0)
At the time of admission	
Upper respiratory tract infection (n, %)	40 (64.5%)
Symptom duration (days) [median (IQR)]	4.0 (4.0-7.0)
Received antibiotics (n, %)	26 (41.9%)
Antibiotic duration (days) (mean±SD, min-max)	4.4±2.3 (7.0-34.0)
Laboratory data [mean±SD (min-max)]	
WBC count (cells/mm^3)	20200±9200 (6300-51700)
ANC (cells/mm^3)	15300±8200 (2000-43300)
ESR (mm/h)	59.4±28.4 (7.0-120.0)
CRP (mg/L)	107.5±79.4 (5.0-427.0)
Radiology (n, %)	
CT	52 (83.9%)
US	14 (22.6%)
CT and US together	13 (20.9%)
Localisation (n, %)	
Parapharyngeal	23 (37.1%)
Peritonsillar	17 (27.4%)
Submandibular	9 (14.5%)
Mixed	7 (11.3%)
Retropharyngeal	6 (9.7%)
Management (n, %)	
Antibiotic alone	29 (46.8%)
Antibiotic + surgery	33 (53.2%)
Timing of surgery (days) [median (IQR)]	2.0 (0.0-12.0)
Antibiotic choice (n, %)	
Clindamycin	38 (61.2%)
Ampicillin sulbactam + clindamycin	14 (22.7%)
Ceftriaxone + clindamycin	10 (16.1%)
Antibiotic duration (days) [mean±SD (min-max)]	17.4±6.3 (7.0-34.0)
Length of stay in the hospital (days) [mean±SD (min-max)]	9.6±3.9 (3.0-21.0)

WBC: white blood cell, ANC: absolute neutrophil count, ESR: erythrocyte sedimentation rate, CRP: C-reactive protein, US: ultrasound, CT: computed tomography.

a 6-year-old boy with a 1.5 cm of mixed abscess and he underwent surgery on the 3th day of admission. All three patients who underwent surgery was successfully treated without any complications. Patients who were surgically treated had larger abscess diameters on CECT compared with patients receiving conservative treatment (2.60±0.94 cm versus 1.95±0.95 cm) (p: 0.025), but we did not find any differences in WBC count, ANC, ESR, or CRP levels. Antibiotic duration and total stay in the hospital also did not differ between surgical and conservative treatment groups (Table 3). To predict the abscess diameter for surgery, ROC analysis was performed and the area under the curve (AUC) was 0.697 (95% confidence interval (CI): 0.533-0.860). At a cut-off level of 2.4 cm, the sensitivity and specificity of abscess diameter for need for surgery were respectively 52.0% and 68.0% (Figure 1). Surgical treatment was more common in patients aged 0-5 years (n: 10, 58.5%) compared with >5 years (n: 23, 51.1%) (p<0.001). The mean duration of antibiotic treatment (intravenous + oral) was 17.4±6.3 days and length of stay in the hospital was 9.6±3.9 days. Antibiotic duration had a negative correlation with age (p<0.001, r: -0.452) and a positive correlation with initial WBC count (p: 0.003, r: 0.389) and ANC (p: 0.020, r: 0.311) but not with ESR or CRP levels. There was no correlation between any laboratory data (erythrocyte sedimentation rate, CRP levels, WBC count, or ANC) and need for surgery. The mean length of stay in the hospital was 9.3±4.2 days in the surgical treatment group and 9.9±5.8 days in the conservative treatment group; there was no difference between these groups. Length of stay in the hospital was negatively correlated with age (p: 0.003, r: -0.382) and had a positive correlation with initial WBC count (p<0.001, r: 0.491) and ANC (p<0.001, r: 0.441) but not with ESR or CRP levels. No patients developed any complications or recurrences and no deaths were observed in our study.

Discussion

Deep neck space abscesses are uncommon but still remain a serious problem with life-threatening consequences in the paediatric population. They often present with nonspecific symptoms, which may make the

Table 2 Symptoms and signs of the patients at the time of admission

Variable	n: 62 (%)
Fever	44 (71.0%)
Sore throat	37 (59.7%)
Limitations of neck range of motion	28 (45.2%)
Neck swelling	27 (43.5%)
Dysphagia	19 (30.6%)
Lymphadenopathy	13 (21.0%)
Neck pain	12 (19.4%)
Trismus	6 (9.7%)
Cough	5 (8.1%)
Torticollis	5 (8.1%)

Table 3 Demographics, laboratory/radiological features, and outcomes of surgical and conservative treatment groups

Variable	Surgical treatment (n: 33)	Conservative treatment (n: 29)	*p* value
Male gender (n, %)	19 (56.5%)	16 (43.5%)	*0.565*
Age in years [median (IQR)]	7.0 (2.0-11.5)	5.5 (3.0-9.3)	*0.555*
At the time of admission (n, %)			
Upper respiratory tract infection	19 (57.6%)	18 (62.0%)	*0.362*
Received antibiotics	15 (45.5%)	11 (37.9%)	*0.811*
Abscess size (cm) [mean±SD (min-max)]	2.60±0.94 (1.0-4.5)	1.95±0.95 (0.7-4.0)	***0.025***
Laboratory data [mean±SD (min-max)]			
WBC count (cells/mm^3)	19340±7730 (8600-48800)	21640±10880 (6300-51700)	*0.511*
ANC (cells/mm^3)	14750±7170 (5900-43300)	16480±9870 (2000-42300)	*0.263*
ESR (mm/h)	60.6±29.0 (7.0-120.0)	56.5±31.7 (17.0-120.0)	*0.743*
CRP (mg/L)	106.7±67.8 (5.0-283.0)	112.6±98.5 (6.2-427.0)	*0.684*
Antibiotic duration (days) [mean±SD (min-max)]	17.7±6.9	17.3±5.8	*0.765*
Length of stay in the hospital (days) [mean±SD (min-max)]	9.3±4.2 (3.0-21.0)	9.9±5.8 (5.0-20.0)	*0.487*

diagnosis a challenge for paediatricians, so a high index of suspicion is crucial. The most common presentations in the present study were fever, sore throat, limitations of neck range of motion, neck swelling, and dysphagia, in agreement with those reported in the literature.[6-10]

Deep neck space abscesses may occur in specific locations according to the patient's age. Previous data showed that peritonsillar abscesses predominated in older children and adolescents but retropharyngeal and parapharyngeal abscesses were more common in younger children.[5] In the present study, peritonsillar abscess was more common in patients aged >5 years, whereas retropharyngeal and parapharyngeal abscesses predominated in children aged 0-5 years, consistent with previous data.[7,14,19]

The most commonly employed radiological modalities to identify DNSAs were CECT and US in our study. Contrast-enhanced computed tomography has become the most widely used imaging technique. The detailed anatomical information provided by CECT is helpful for surgical planning of patients who require surgical intervention.[7] Meyer et al recommended performing CT for all children with a concerning diagnosis for DNSAs, because no factor appeared to be predictive of abscess on CT. In addition, the duration of symptoms did not predict the finding of an abscess on CT.[20] However, the sensitivity and specificity ranges respectively vary between 63% and 95% and between 45% and 65% in the literature, and CT has some limitations in differentiating abscesses from cellulitis along with high radiation exposure. Ultrasound was reported to provide useful information for superficial lesions but it offers poor visualisation of deeper neck space collections. In addition, the use of US depends on the skill level of the radiologist. As the first-line choice, MRI was considered reasonable; it provides higher contrast resolution in pus detection and avoids exposure to ionizing radiation.[9,13,14,21,22] However, it was not preferred as the first-line imaging modality in our study due to the need for sedation, and it may not be readily available in some cases in our hospital. It was stated that radiological examination could be delayed for 48 hours if there was no airway compromise or signs of complications, so MRI could be preferred to achieve more accurate imaging in the management of paediatric DNSAs.[23]

Researchers recommend clindamycin, penicillin with a β-lactamase inhibitor, or a β-lactamase-resistant antibiotic with a drug against most anaerobes as empirical treatment.[5,24] The most preferred antibiotics in our study were clindamycin alone, a combination of ampicillin sulbactam + clindamycin, and ceftriaxone + clindamycin, in accordance with the literature. The mean duration of antibiotic treatment was 17.4±6.3 days, which was longer than recent findings recommending a 14-day antibiotic course, representing a more strict conformity to indications.[25]

There still remains uncertainty about which patients can be managed successfully without surgical intervention. In a study including both adult and paediatric patients, a clinical score with sensitivity of 73.7% and specificity of 92.3% was proposed to determine the need for surgery. Positive peripheral rim enhancement on CT scan, CRP level of >41.25 mg/L, sedimentation rate of >56 mm/h, and neutrophil-to-lymphocyte ratio of >8.02 were identified as major factors associated with surgical intervention.[26] Çetin et al evaluated paediatric DNSAs and concluded that patients with a baseline WBC count of ≤25200/mm^3, with two or less than two cervical compartments, and without complications on admission could be treated successfully with conservative treatment.[27] In three paediatric studies including 178, 101, and 93 cases, abscess diameters of >2.2 cm, >2 cm, and >2.5 cm were found to predict the need for surgery.[13,18,28] In a review evaluating paediatric DNSAs, indications for surgery included airway compromise, presence of complications, no clinical improvement after 48 hours of intravenous antibiotic treatment, abscess diameter of >2.2 cm on CT, age of <4 years, and intensive care unit admission.[5] In another paediatric review, it was stated that the pooled success rate of conservative treatment in avoiding surgery was 0.517 (95% CI: 0.335-0.700), and when patients with immediate surgical intervention were excluded, the success rate was 0.991 (95% CI: 0.851-1.051), suggesting that conservative management could be a safe alternative to surgery.[29] In another trial, age less than 51 months was identified as a predictor for surgery.[28] In our study, we found that an abscess diameter greater than 2.4 cm was associated with surgical intervention. Although surgical management was slightly more common in patients younger than five years, we did not find any difference in age or any laboratory data between the surgical and conservative treatment groups. However, mean WBC count, ANC, ESR, and CRP levels were consistently increased and showed a status of inflammation. Likewise, Wilkie et al[18] and Raffaldi et al[30] concluded that age, WBC count, and CRP were not predictive of requirement for surgery.

Our results support the findings of previous studies as nearly half of the patients were successfully treated with antibiotics alone.[18,25,28] There is still debate on the timing of

the surgical approach. We found no difference in length of stay in the hospital comparing patients who underwent immediate or delayed surgery, as previously reported by Johnston et al.[31] Cramer et al[17] highlighted that there was no association between timing of surgery and morbidity and mortality in children, although they found delayed surgical drainage to increase morbidity and mortality in an adult population. The overall time interval between admission and surgery was a median of 2.0 days (IQR: 0.0-12.0) in our study, which means that some of our patients underwent surgery in the first 48 hours. Surgery was recommended for patients with complications, larger abscesses, and no clinical improvement after a 48-h period of intravenous antibiotic treatment.[5] Thus, we wonder whether surgical intervention could be delayed until the 48 hours of the antibiotic course are completed.

Of all pus specimens, 38.5% resulted in positive cultures, a rate that was lower than expected. In a recent study, Donà et al[25] reported a 64.3% rate of positive pus specimens in paediatric DNSAs. This may be explained by the fact that many of the patients received antibiotics before referral at our hospital and all patients received antibiotic treatment from diagnosis to time of surgery.

Complications of DNSAs were calculated with an incidence of 2.2%.[28] Another trial reported a complication rate of 9.4% and concluded that higher complication rates were observed in younger children with retropharyngeal abscesses. *Staphylococcus aureus* was also more likely to be identified as the causative microorganism in children who developed complications. In another study, *Staphylococcus aureus* was identified more commonly in children aged <1 year.[3,28,32] Fortunately, we encountered no complications in the present study. There was no difference in length of stay in the hospital in our patients who were managed medically or surgically, consistent with the literature. This may be explained by conservative management being indicated for patients without complications or with smaller abscess size. We think it is reasonable to encourage a more conservative treatment strategy. Length of stay in the hospital was negatively correlated with age and had a positive correlation with initial WBC count and ANC but not with ESR or CRP levels in our study. Likewise, Bolton et al[33] reported that higher WBC count was associated with longer stay in the hospital.

The limitation of our study lies in its retrospective nature. We used ICD codes to identify patients, but missing data may lead to the underestimating of the real number of cases. Furthermore, the data were obtained from a single medical centre, so the sample size was relatively small due to the low prevalence of the disease.

In conclusion, DNSAs may present with a wide range of nonspecific symptoms and signs and serious complications may develop, so a high index of suspicion and prompt management are crucial. Surgical treatment was more common in patients aged <5 years. The abscess size was determined as the most important factor to help the physician select the treatment strategy. Although a lack of consensus on the optimal management or timing for surgery still remains, conservative treatment with close follow-up can be successfully applied in selected cases. Further research should focus on proposing a standardised management protocol for paediatric DNSAs.

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Declaration of Conflicting of Interests

The authors declare no conflict of interest.

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