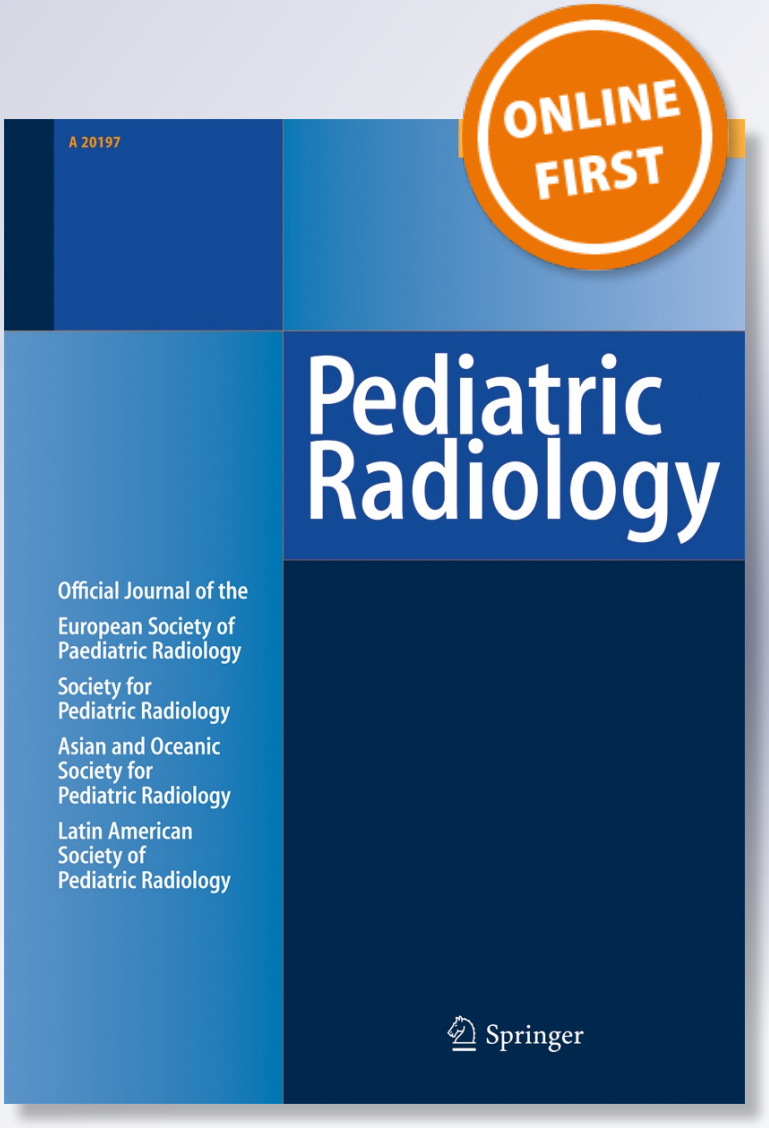
Tonsil ultrasound: technical approach and spectrum of pediatric peritonsillar infections

Anjum N. Bandarkar, Adebunmi O. Adeyiga, M. Taylor Fordham, Diego Preciado & Brian K. Reilly

Pediatric Radiology

ISSN 0301-0449

Pediatr Radiol
DOI 10.1007/s00247-015-3505-7



Springer

Pediatr Radiol
DOI 10.1007/s00247-015-3505-7

PICTORIAL ESSAY

Tonsil ultrasound: technical approach and spectrum of pediatric peritonsillar infections

Anjum N. Bandarkar[1] · **Adebunmi O. Adeyiga**[1] · **M. Taylor Fordham**[2] · **Diego Preciado**[3] · **Brian K. Reilly**[3]

Received: 22 June 2015 / Revised: 10 October 2015 / Accepted: 9 November 2015

Abstract Peritonsillar infections are one of the most common deep neck space infections, particularly in adolescents. Inaccurate diagnosis can lead to delay in management and potentially life-threatening complications. Contrast-enhanced computed tomography (CT) scan of the neck traditionally has been used to diagnose suspected peritonsillar abscess. With growing concern over radiation exposure, there has been increasing utilization of ultrasound (US) using intraoral and transcutaneous approaches. We chose the transcutaneous US technique due to its ease of performance in children. The purpose of this article is twofold: a) to describe our technique of performing transcutaneous US of the tonsil showing sonographic appearance of normal tonsil, highlighting pertinent anatomy and unique considerations for this modality in children, and b) to illustrate the sonographic findings in the spectrum of pediatric peritonsillar infections, which includes uncomplicated tonsillitis, peritonsillar cellulitis, small intratonsillar abscess and frank peritonsillar abscess. Parapharyngeal abscess can sometimes be detected.

✉ Anjum N. Bandarkar
anjumnb@gmail.com

[1] Division of Diagnostic Imaging and Radiology, Children's National Health System, Washington, DC, USA

[2] Department of Otolaryngology, Children's Hospital of San Antonio, San Antonio, TX, USA

[3] Department of Pediatric Otolaryngology, Children's National Health System, Washington, DC, USA

Keywords Abscess · Children · Infection · Peritonsillar infection · Tonsil · Ultrasound

Introduction

Peritonsillar infections are commonly encountered in pediatric clinical practice. The infection usually begins as a superficial infection or tonsillitis and progresses through peritonsillar cellulitis to the end point of peritonsillar abscess, which can be potentially life-threatening. Peritonsillar abscess is characterized by the collection of purulent fluid between the palatine tonsillar capsule medially and the fascia of the superior constrictor muscle laterally [1, 2]. It affects children and adults but is more common in adolescents, with an estimated incidence of between 14 and 40 per 100,000 in patients younger than 18 years old [1]. Complications of peritonsillar abscess include sudden rupture with aspiration, extension of the infection into the mediastinum, acute airway obstruction and/or sepsis [2, 3]. Therefore, an accurate diagnosis is crucial.

Due to the similar clinical presentation, differentiation of peritonsillar abscess from peritonsillar cellulitis or uncomplicated tonsillitis can be very challenging based on clinical exam alone. This distinction, however, is critical as the management of these two entities is often different [4–6]. Contrast-enhanced CT scan is frequently used to confirm the diagnosis; however, it is far from ideal due to its high cost and radiation dose, which can be up to 3 mSv [7]. Needle aspiration is considered the gold standard for diagnosis and treatment but can be extremely difficult in awake children due to its invasive and painful nature [4, 8].

Published online: 05 December 2015

Ultrasound has been shown to reliably distinguish peritonsillar abscess from peritonsillar cellulitis in a number of small-scale studies with adults [9–13]. There are numerous reports of use of intraoral ultrasound (US) to assess peritonsillar abscess in adult emergency medicine, but the procedure may not be well tolerated in children due to trismus as well as the size of the intracavitary probe. The transcutaneous US approach is easier technically and much less frightening for children. It is quickly performed and eliminates the need for topical anesthetic spray in the oropharynx. Hence, in our institution, we have been using transcutaneous US as the primary imaging modality to confirm peritonsillar abscess.

Transcutaneous sonography of tonsils: technique and protocol

How do you find the tonsil?

With the transducer positioned over the skin under the mandible, the submandibular gland is located first. It is seen as a well-capsulated homogeneously echogenic soft-tissue structure beneath the mandible. The tonsil is found immediately deep to the submandibular gland (Fig. 1). The soft tissues of the floor of mouth including the tongue are seen medially and the facial vessels are situated laterally (Fig. 2).

Patient position The patient is kept in supine position with the neck extended while scanning. In case of drooling and inability to lie supine, scanning can be performed in semi-recumbent or sitting position. Care should be taken to exclude epiglottitis clinically or with a portable lateral airway radiograph prior to attempting US examination.

Transducer A linear high frequency transducer is used, typically 9 to 15 MHz. During scanning via the submandibular approach, the transducer is directed posteriorly and cephalad with the probe marker facing the patient's right side. For scanning in the midline approach, the transducer is held transversely in the midline suprahyoid neck.

Approach Scanning can be performed via submandibular and midline approach.

1. Submandibular approach: Transcutaneous sonography of the tonsils is performed by placing the transducer externally over the submandibular region of neck, just medial to the angle of the mandible [1, 4]. The entire tonsillar fossa is imaged by focusing the transducer deep to the ipsilateral submandibular gland in order to look for any fluid collection involving the tonsil (Fig. 3). The tonsils are identified with ease in all children from toddlers to teenagers. Using this approach, the tonsil is visualized in both transverse and longitudinal planes.
2. Midline approach: A midline transverse plane can be used to show both tonsils at the same time by placing the transducer horizontally in the submental region (Fig. 4). The tonsils are projected on either side of the midline. This view gives a quick idea of relative involvement of tonsils.

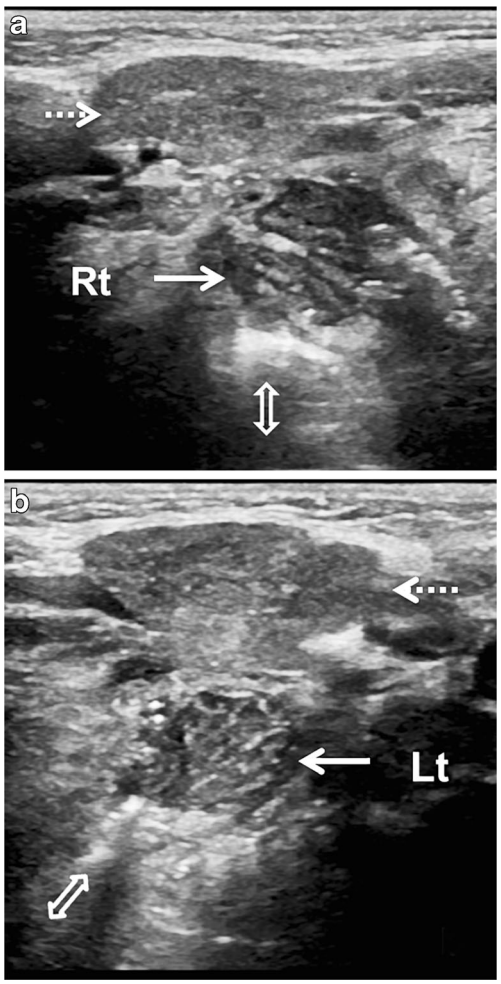


Fig. 1 Normal bilateral tonsils in an asymptomatic 10-year-old girl. **a** Gray-scale transverse image of right (*Rt*) neck and (**b**) of the left (*Lt*) neck show normal tonsils (*solid arrows*) located deep to the ipsilateral submandibular gland (*dotted arrows*). Dense echogenic specks due to reverberation artefact (*bidirectional arrows*) can be seen along the medial and posterior aspect of the tonsil representing foci of air in the pharynx

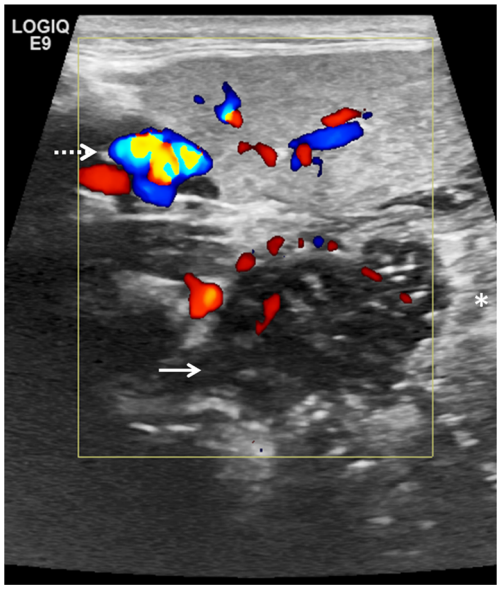


Fig. 2 Color Doppler transverse image of the right tonsil in a 5-year-old asymptomatic girl shows normal vascularity of the right tonsil (*solid arrow*). The right facial artery and vein (*dotted arrow*) are located along the lateral aspect of the submandibular gland depicted anterior to the tonsil. Part of the tongue (*asterisk*) is seen located medial to the tonsil

Protocol In experienced hands, transcutaneous tonsil US can be performed in less than 5-10 min. Our protocol is as follows:

a. Gray-scale images of the tonsil are documented in transverse and longitudinal planes, one side at a time, to include both affected and unaffected sides. Midline image is obtained when possible.
b. Tonsillar size is measured in a minimum of two planes, transverse and longitudinal.
c. Color Doppler is used to show regional hyperemia, lack of intrinsic vascularity in any focal fluid collection that may represent an abscess, and to identify major neck vessels.
d. We also obtain cineloops of each tonsil in the transverse plane to capture the entire tonsillar fossa and peritonsillar soft tissues in a real-time video clip that can be reviewed later.
e. Regional lymph node evaluation is included in the protocol.

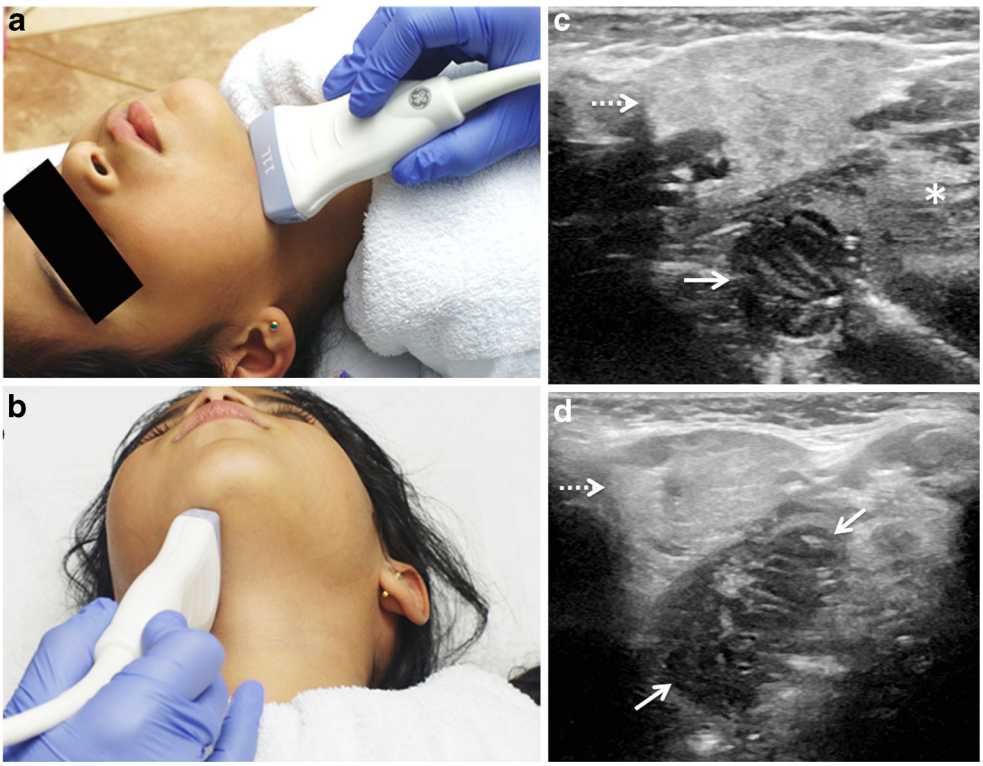


Fig. 3 Tonsil US performed via submandibular approach on a 6-year-old volunteer (a coauthor's child). **a** The image shows the correct placement of the linear transducer in the transverse plane, the right tonsil is being imaged with the probe marker facing the patient's right ear in the transverse plane. **b** The image shows the transducer held in the longitudinal plane underneath the mandible with the marker directed cranially in the longitudinal plane. **c** Gray-scale transverse image of the right submandibular region shows the right tonsil (*arrow*) as an ovoid hypoechoic structure located deep to the submandibular gland (*dotted arrow*). The right half of the tongue (*asterisk*) is seen located medial to the tonsil. This high frequency image clearly depicts the striated appearance of the tonsil. **d** Gray-scale sagittal image of the right submandibular region shows the right tonsil (*between solid arrows*) in maximum longitudinal dimension. *Dotted arrow* indicates the submandibular gland

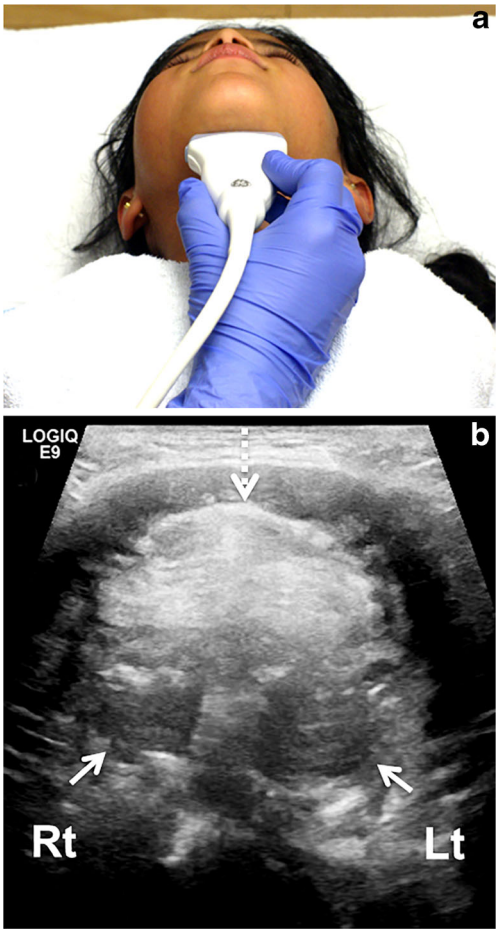


Fig. 4 Tonsil US performed via midline approach on a 6-year-old volunteer (a coauthor's child). **a** The image shows the correct placement of the linear transducer in the midline transverse plane with the neck fully extended and the probe marker facing the patient's right ear. **b** Midline gray-scale transverse image obtained through the suprahyoid neck via midline approach shows both tonsils (*solid arrows*), one on either side of the midline (*dotted arrow*). This view is less often performed since it is technically harder to obtain without difficulty due to the depth of tissues involved. The tonsils are moderately enlarged in this patient with uncomplicated tonsillitis. She was managed successfully with antibiotics

Sonographic anatomy of the tonsil

What does the normal tonsil look like on ultrasound?

The palatine tonsil is an ovoid, solid lymphoid gland located in the lateral wall of the oropharynx, between the anterior and posterior pillars. It is bounded by the palatoglossus muscle anteriorly and the palatopharyngeus and superior constrictor muscles posteriorly and laterally. The tonsillar surface is irregular with numerous ingrowths of the surface epithelium known as tonsillar crypts.

Sonographically, the tonsil is seen as a well-defined, ovoid soft-tissue structure with subtly lobulated margins. It is hypoechoic to the adjacent submandibular gland. The tonsillar parenchyma has a striated appearance with alternating linear hyperechoic and hypoechoic bands. The striated appearance is due to the tonsillar crypts. Often, dense echogenic mobile specks can be seen along the medial aspect of the tonsil and these represent foci of air in the pharynx (Fig. 1) [4].

Normal tonsillar measurement

The tonsils reach maximum size at puberty and measure up to 2 cm in longitudinal dimension [4, 10]. In our experience, the transverse and anteroposterior dimension measured up to 1.5 cm in a normal tonsil, while the longitudinal length could measure just over 2 cm. There are no studies showing normal tonsil volumes at this time.

The length and anteroposterior dimension are best measured on the longitudinal view, which may be technically difficult to obtain, while the transverse dimension is best measured on the transverse view which is usually obtained easily (Fig. 5).

The sonographic spectrum of tonsillar and peritonsillar infections includes:

1. Uncomplicated tonsillitis: Tonsillitis refers to inflammation of the tonsil, either bacterial or viral, and manifests as tonsillar hypertrophy without fluid collection. Sonographically, the affected tonsil shows increase in size greater than 2 cm in at least one dimension, with preserved homogeneous echotexture. In our practice (unpublished data), we classified tonsils into three sonographic subtypes (Figs. 6 and 7) based on degree of enlargement in either transverse or longitudinal plane: mild - 2 to 3 cm, moderate - 3 to 4 cm, and severe - greater than 4 cm.
2. Peritonsillar cellulitis: Peritonsillar cellulitis is an inflammatory reaction of the tissue between the capsule of the palatine tonsil and the pharyngeal muscles, which is caused by infection, but not associated with a discrete collection of pus. An alternate term for cellulitis is phlegmon [14]. Peritonsillar cellulitis is considered to be an intermediate state between uncomplicated tonsillitis and frank peritonsillar abscess. The sonographic appearance can be variable depending upon the degree of inflammation. Typically, the tonsil is enlarged with heterogeneous parenchyma and marked surrounding soft-tissue edema, which is visualized as perifocal increased echogenicity. The

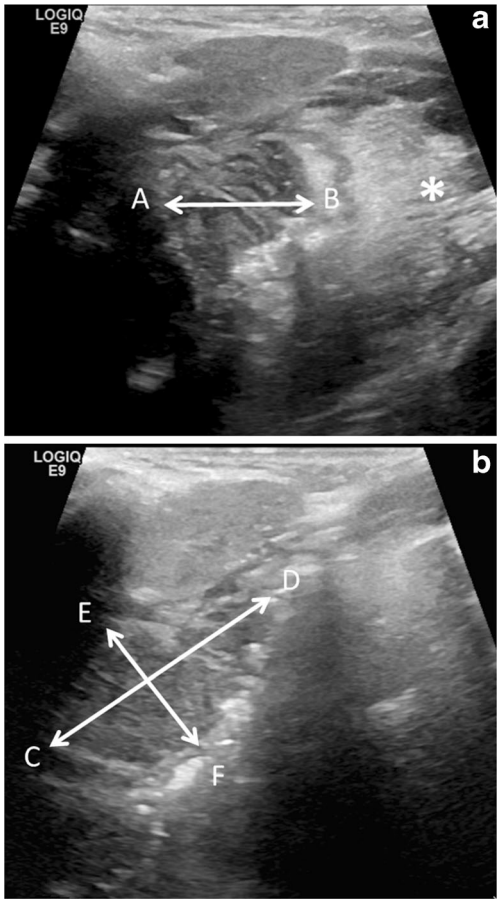


Fig. 5 Tonsil measurements in a boy, age 3 years 11 months, with tonsillitis. **a** Gray-scale transverse image of the right tonsil shows the transverse dimension AB (1.7 cm) and (**b**) the longitudinal view of the right tonsil shows maximum length CD (3.2 cm) and anteroposterior thickness EF (1.7 cm). Tonsil volume was calculated to be 4.8 cc. The tongue (*) is along the medial aspect of the right tonsil on the transverse image

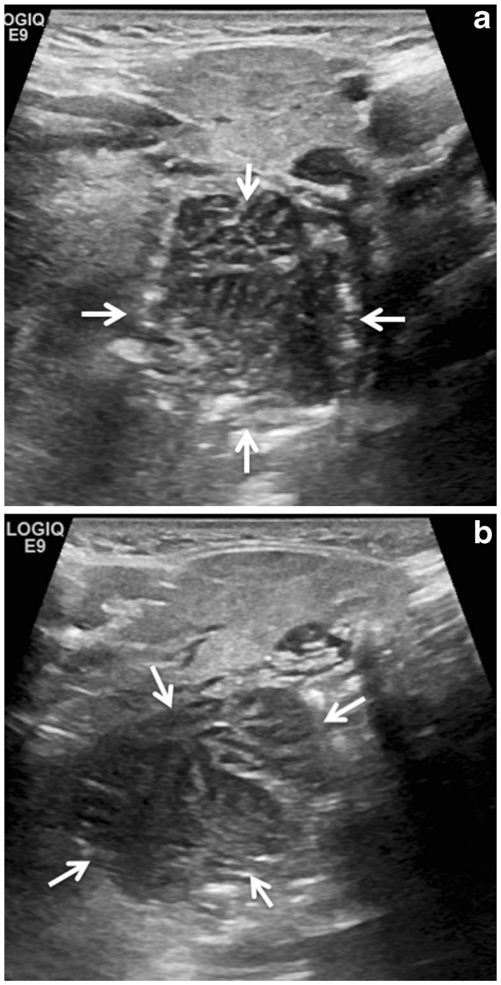


Fig. 6 Uncomplicated moderate tonsillitis in a 16-year-old girl with a 1-week history of sore throat and odynophagia. **a** Gray-scale transverse image of the left neck and (**b**) gray-scale longitudinal image of the left neck show an enlarged left tonsil (*between arrows*). The tonsil measured 3.2 cm in maximum dimension, compatible with moderate enlargement. Note preserved striated architecture of tonsillar parenchyma suggesting the uncomplicated nature of tonsillitis

tonsillar parenchyma may show small ill-defined internal hypoechoic areas that may represent developing pockets of edema, hemorrhage, necrosis or purulence (Figs. 8 and 9). The majority of the hypoechoic areas measure less than 1 to 1.5 cm in size, and a well-defined abscess cannot be appreciated. Patients are initially managed conservatively and reassessed in 24 h after starting antibiotics.

3. Intratonsillar abscess: Less commonly, there may be a small intratonsillar hypoechoic pocket that represents an intratonsillar abscess. This term may be used to describe a discrete fluid collection with a rim of tonsillar parenchyma surrounding the fluid pocket on all sides (Figs. 10 and 11). Clinically stable children with small intratonsillar abscess respond well to intravenous antibiotics [15].
4. Peritonsillar abscess: Peritonsillar abscess is a collection of pus located between the capsule of the palatine tonsil and the pharyngeal muscles. When present, a peritonsillar abscess is seen as a well-circumscribed hypoechoic or anechoic fluid-filled cavity with irregular margins (Figs. 12, 13, and 14) typically along the posterolateral aspect of tonsil. The location of abscess, size and volume can be determined on the sonogram. Contrast-enhanced neck CT shows the abscess as a rim-enhancing hypodense fluid collection. A small peritonsillar abscess, measuring less than 2 cm in size may improve on antibiotics alone [16].
5. Parapharyngeal abscess/phlegmon: Parapharyngeal abscess/phlegmon is a deep neck infection involving

Fig. 7 Uncomplicated severe tonsillitis in a 16-year-old boy presenting with throat pain described as 10/10 in severity and trismus and no fever. Gray-scale transverse image of the left neck shows a markedly enlarged tonsil between the arrows (tonsil size was 5×4.4×4 cm). Note the heterogeneous echotexture of tonsillar parenchyma suggesting inflammatory change. The adjacent left submandibular gland (*s*) appears diminutive in comparison with the tonsil. The right tonsil (not shown) was similarly enlarged. The patient responded well to antibiotics

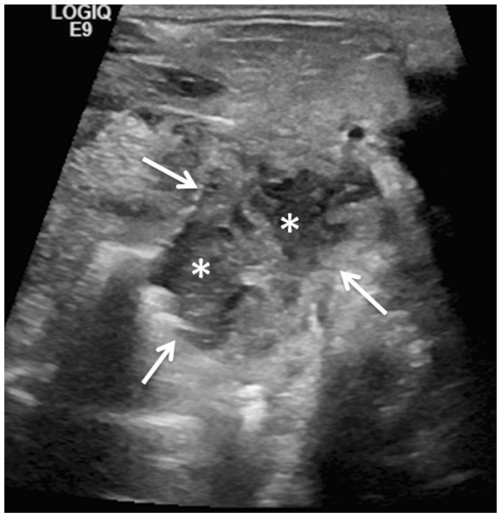


Fig. 9 Peritonsillar cellulitis in a 13 year-old boy with 6 days of throat pain, left palatal swelling and trismus. Gray-scale transverse image of the left neck shows an enlarged tonsil (*arrows*) with ill-defined margins and markedly increased echogenicity of surrounding soft tissues that suggests significant inflammatory change/cellulitis. There are two irregular hypoechoic areas (*) within the tonsil that may represent pockets of developing purulence or necrosis; they measured 1.5 and 1.6 cm in maximum dimension. These were called intratonsillar abscesses; however, no pus was obtained on bedside incision and drainage. The pockets were either too small and missed (incision and drainage was performed without US guidance) or the contents were not liquefied sufficiently to be aspirated. The patient improved with antibiotics and there were no return visits

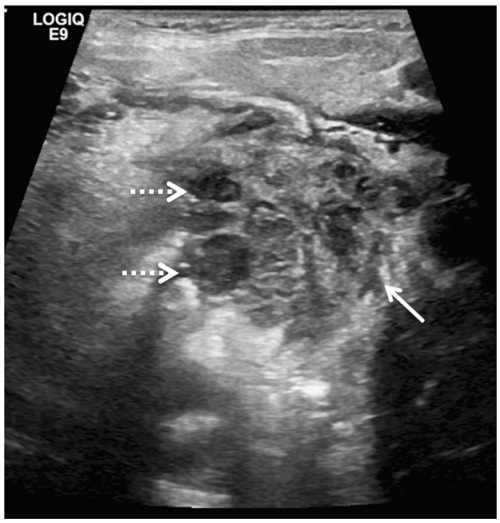


Fig. 8 Peritonsillar cellulitis in a 15-year-old girl with 3 days of sore throat, decreased oral intake and mild trismus. Gray-scale transverse image of the left neck shows a markedly enlarged tonsil (*solid arrow*) measuring 4.2 cm in maximum dimension. The tonsillar parenchyma is heterogeneous with scattered hypoechoic areas (*dotted arrows*) within, which may represent pockets of developing edema, purulence or necrosis. The increased echogenicity of surrounding soft tissues suggests marked inflammatory change. Due to the small size of the pockets, surgical intervention was deferred and the patient was managed medically

Fig. 10 Intratonsillar abscesses in a 9-year-old girl with 6 days of throat pain, odynophagia and mild fever. Gray-scale transverse image of the left neck shows an enlarged tonsil with heterogeneous parenchyma and surrounding cellulitis. There are three irregular hypoechoic areas (*) within the tonsil that are fairly well circumscribed and may represent pockets of developing purulence or necrosis. The largest measured 1.5 cm in maximum dimension; the other two were subcentimeter in size. These were called intratonsillar abscesses. Due to their small size, they were managed medically

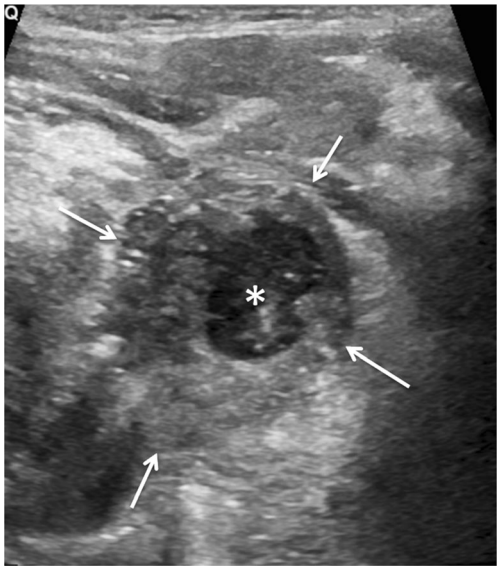


Fig. 11 Intratonsillar abscess in a 12-year-old boy with 3 days of throat pain and palatal swelling. Gray-scale transverse image of the left neck shows an enlarged tonsil (*enclosed in arrows*) with surrounding cellulitis. There is a well-circumscribed hypoechoic area (*) measuring 1.5×1.0 cm within the tonsil that may represent a pocket of developing purulence or necrosis. Due to the small size and favorable clinical findings, the patient was treated with antibiotics

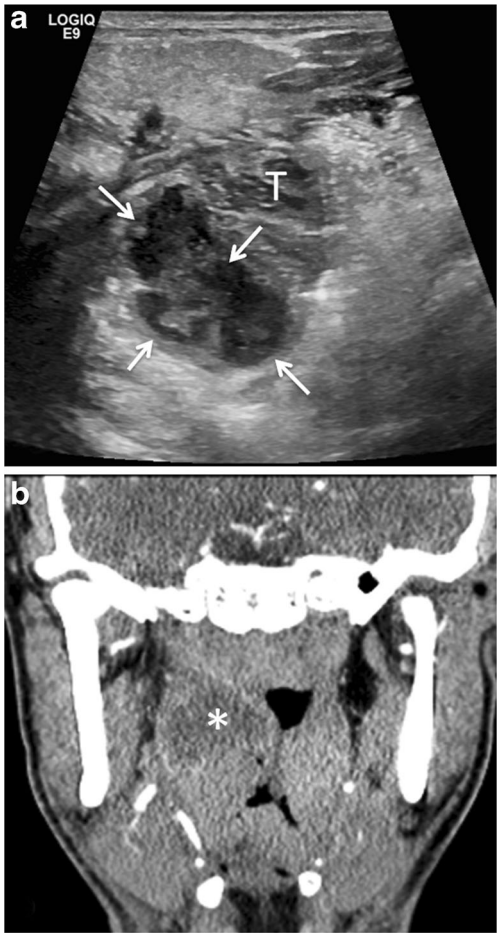


Fig. 13 Peritonsillar abscess in a 17-year-old boy with 7 days' history of sore throat and trismus. On clinical exam, he had right palatal fullness and deviation of uvula to the left. **a** Gray-scale transverse image of the right neck shows an enlarged tonsil (*T*) with a focal irregularly marginated hypoechoic area (*between arrows*) measuring 3.1×2.5×1.8 cm along the lateral aspect of the left tonsil, compatible with peritonsillar abscess. **b** Coronal contrast-enhanced CT scan of the neck (performed at an outside hospital prior to presentation) shows the right-side peritonsillar abscess (*). During incision and drainage in the operating room, 10 ml of pus was obtained

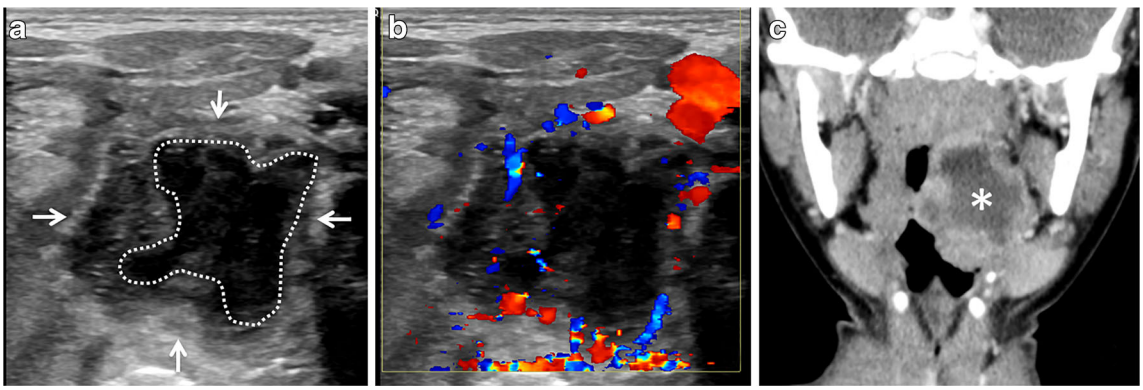


Fig. 12 Peritonsillar abscess in a 5-year-old boy with 5 days' history of streptococcal pharyngitis, tenderness in the left neck and trismus. **a** Gray-scale transverse image of the left neck shows an enlarged tonsil (*between arrows*) with a focal irregularly marginated hypoechoic area (*outlined*) measuring 2.7×2.5×2.3 cm along the lateral aspect of the left tonsil, compatible with peritonsillar abscess. **b** Color Doppler image shows lack of internal vascularity in the abscess with peripheral hyperemia. **c** Coronal contrast-enhanced CT scan of the neck also shows the left-side peritonsillar abscess (*). Incision and drainage in the operating room yielded copious amounts of frank pus

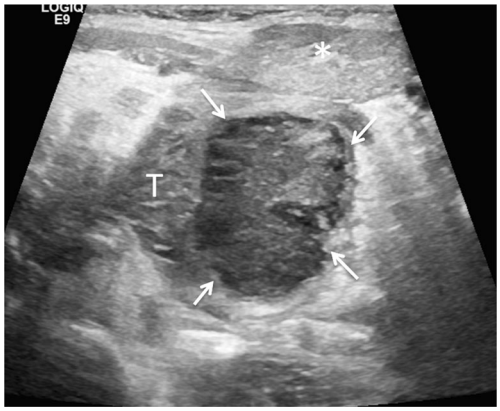


Fig. 14 Peritonsillar abscess in a 10-year-old girl with 5 days' history of sore throat, odynophagia, an inability to handle secretions and uvular deviation. Gray-scale transverse image of the left neck shows an enlarged tonsil (*T*) with a thick-walled hypoechoic area (*between arrows*) measuring 3.1×1.8×1.7 cm along the lateral aspect of the left tonsil, compatible with peritonsillar abscess. The left submandibular gland (*) is located superficially. She underwent incision and drainage in the operating room and copious pus was expressed

the parapharyngeal space. It can develop at any age but is most commonly seen in children and adolescents. Initially, symptoms are similar to acute pharyngitis or uncomplicated tonsillitis and may progress due to spreading inflammation and infection. Figure 15 shows a parapharyngeal phlegmon that was detected on neck US being performed to look for suspected peritonsillar abscess. In a patient with a parapharyngeal abscess or phlegmon, the tonsil itself will be identified separately from the abscess, which will be typically posterior to the tonsil and not contiguous with it. Once the tonsil is shown to be uninvolved on sonography, additional cross-sectional imaging could be considered. CT scan of the neck may help to identify concomitant spread of infection to other neck spaces [13].

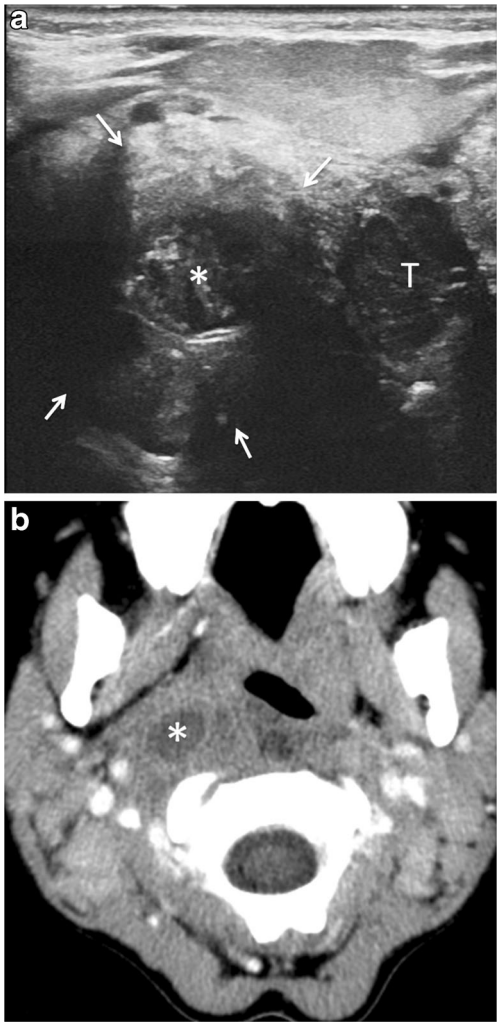


Fig. 15 Parapharyngeal phlegmon in a 5-year-old boy with 6 days of right neck pain and stiffness, fever and trismus. **a** Gray-scale transverse image of the right neck shows a mildly enlarged right tonsil (*T*) with the submandibular gland seen anteriorly. There is a focal round, heterogeneously hypoechoic area (*) measuring 1.7×1.5 cm located posterolateral to the right tonsil that is concerning for developing abscess pocket. Significant perifocal donut-shaped soft-tissue thickening is noted suggesting phlegmon formation (*between arrows*). There is no peritonsillar abscess. **b** Axial contrast-enhanced CT scan of the neck confirms the right-side parapharyngeal hypodense rim-enhancing pocket (*). Upon incision and drainage, less than 1 cc of dirty fluid was aspirated but there was no frank pus

Conclusion

Knowledge of sonographic appearance of the normal tonsil and various peritonsillar infections can help the radiologist make the correct diagnosis. Accurate diagnoses positively impact management decisions and patient care. Transcutaneous US is an ideal diagnostic modality for evaluation of the tonsils in children, and it can reliably differentiate peritonsillar abscess from other tonsillar infections. It is quick, noninvasive, painless, cost-effective and easily available. Furthermore, it does not require ionizing radiation or sedation. In our institution, transcutaneous US is an integral part of the algorithm (Fig. 16) to evaluate for peritonsillar abscess, and it plays a critical role in identifying patients who will not need surgical intervention.

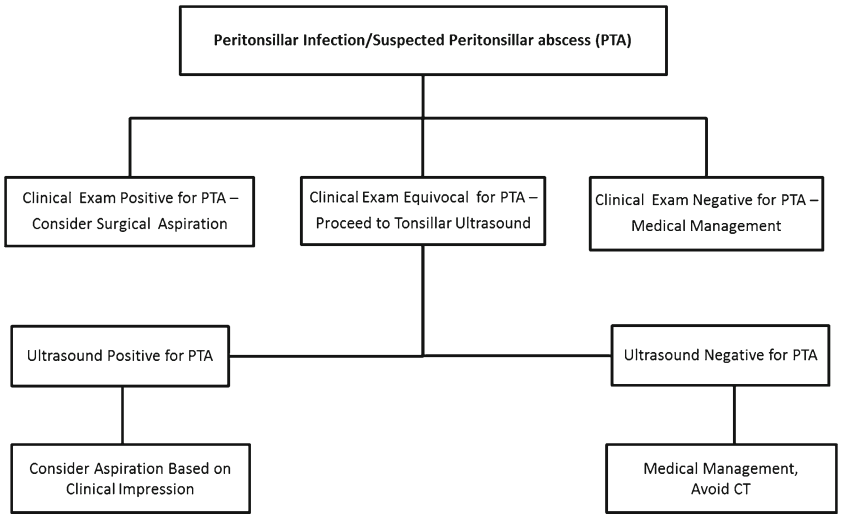


Fig. 16 Algorithm for management of peritonsillar abscess

Acknowledgments We would like to express our sincere appreciation to our stellar sonographers - Cathy Brown Jones, Tara Cielma, Amanda George, Pamela Handelman, Megan Hartman, Danyelle Holley, Suella Jones, Kadine Linden, Linda Rebolo, Courtney Ruiz and Roza Zenelaj, for their expertise and insight. We are grateful to Dr. Asif Momin for his scientific guidance. We also thank Drs. Anna Blask and Eglal Shalaby-Rana for their critical comments.

Compliance with ethical standards

Conflicts of interest None

References

1. Steyer TE (2002) Peritonsillar abscess: diagnosis and treatment. Am Fam Physician 65:93–96
2. Millar KR, Johnson DW, Drummond D et al (2007) Suspected peritonsillar abscess in children. Pediatr Emerg Care 23:431–438
3. Herzon FS, Nicklaus P (1996) Pediatric peritonsillar abscess: management guidelines. Curr Probl Pediatr 26:270–278
4. Buckley AR, Moss EH, Blokmanis A (1994) Diagnosis of peritonsillar abscess: value of intraoral sonography. AJR Am J Roentgenol 162:961–964
5. Strong EB, Woodward PJ, Johnson LP (1996) Intraoral ultrasound evaluation of peritonsillar abscess. Laryngoscope 105:779–782
6. Ahmed K, Jones AS, Shah K et al (1994) The role of ultrasound in the management of peritonsillar abscess. J Laryngol Otol 108:610–612
7. Mettler FA Jr, Huda W, Yoshizumi TT et al (2008) Effective doses in radiology and diagnostic nuclear medicine: a catalog. Radiology 248:254–263
8. Scott PM, Loftus WK, Kew J et al (1999) Diagnosis of peritonsillar infections: a prospective study of ultrasound, computerized tomography and clinical diagnosis. J Laryngol Otol 113:229–232
9. Rehrer M, Mantuani D, Nagdev A (2013) Identification of peritonsillar abscess by transcutaneous cervical ultrasound. Am J Emerg Med 31:267.e1-3
10. Lyon M, Glisson P, Blaivas M (2003) Bilateral peritonsillar abscess diagnosed on the basis of intraoral sonography. J Ultrasound Med 22:993–996
11. Powell J, Wilson JA (2012) An evidence-based review of peritonsillar abscess. Clin Otolaryngol 37:136–145
12. Sakaguchi M, Sato S, Asawa S et al (1995) Computed tomographic findings in peritonsillar abscess and cellulitis. J Laryngol Otol 109: 449–451
13. Baker KA, Stuart J, Sykes KJ et al (2012) Use of computed tomography in the emergency department for the diagnosis of pediatric peritonsillar abscess. Pediatr Emerg Care 28: 962–965
14. Wald ER Peritonsillar cellulitis and abscess. In: UpToDate. Accessed 20 Jan 2014. Retrieved from http://www.uptodate.com/contents/peritonsillar-cellulitis-and-abscess
15. Ulualp SO, Koral K, Margraf L et al (2013) Management of intratonsillar abscess in children. Pediatr Int 55:455–460
16. Fordham MT, Rock AN, Bandarkar A et al (2015) Transcervical ultrasonography in the diagnosis of pediatric peritonsillar abscess. Laryngoscope. doi:10.1002/lary.25354