9 Skull and Sinus

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9.1 Sinus

Traditional outpatient diagnosis of acute rhinosinusitis frequently results in overuse of antibiotics. Point-of-care ultrasound (POCUS) of the maxillary sinus is specific for clinically important fluid, but may miss subtle abnormalities that are rarely clinically important. The ethmoid and frontal sinuses are more challenging to image and are infrequently abnormal in isolation from the maxillary sinus. The absence of maxillary sinus fluid is a strong reason to avoid antibiotics in most patients, and helps reassure them. However, a patient with fever, severe symptoms suggestive of sinusitis, but no fluid with maxillary ultrasound, may need a computerized tomography (CT) scan to look for isolated ethmoid, frontal, or sphenoid sinusitis. A few clinical studies, and our clinic's experience, suggest that ultrasound can substantially reduce antibiotic use for sinusitis [1–3], although there are no large randomized trials to confirm this. Only 23% of patients suspected of sinusitis in our clinic had positive ultrasound [3]. The presence of fluid does not differentiate between viral and bacterial disease, so the final antibiotic decision requires integration of ultrasound with the rest of the patient findings.

The critical care patient who cannot be placed completely upright (ideal when possible) can be a greater diagnostic challenge, as fluid in a partially-filled sinus may be present but not visible when it layers dependently with a buffer of air between it and the probe. When visible, however, fluid in the maxillary sinus of a recumbent or semi-upright patient can be very helpful amongst febrile, intubated patients without a fever source, potentially avoiding CT scans, their associated cost, radiation, and risk of transportation [4, 5]. Figs. 9.1, 9.2, 9.3, 9.4, 9.5, 9.6 and 9.7.

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B. P. Nelson et al. (eds.), *Atlas of Handheld Ultrasound*, https://doi.org/10.1007/978-3-319-73855-0_9

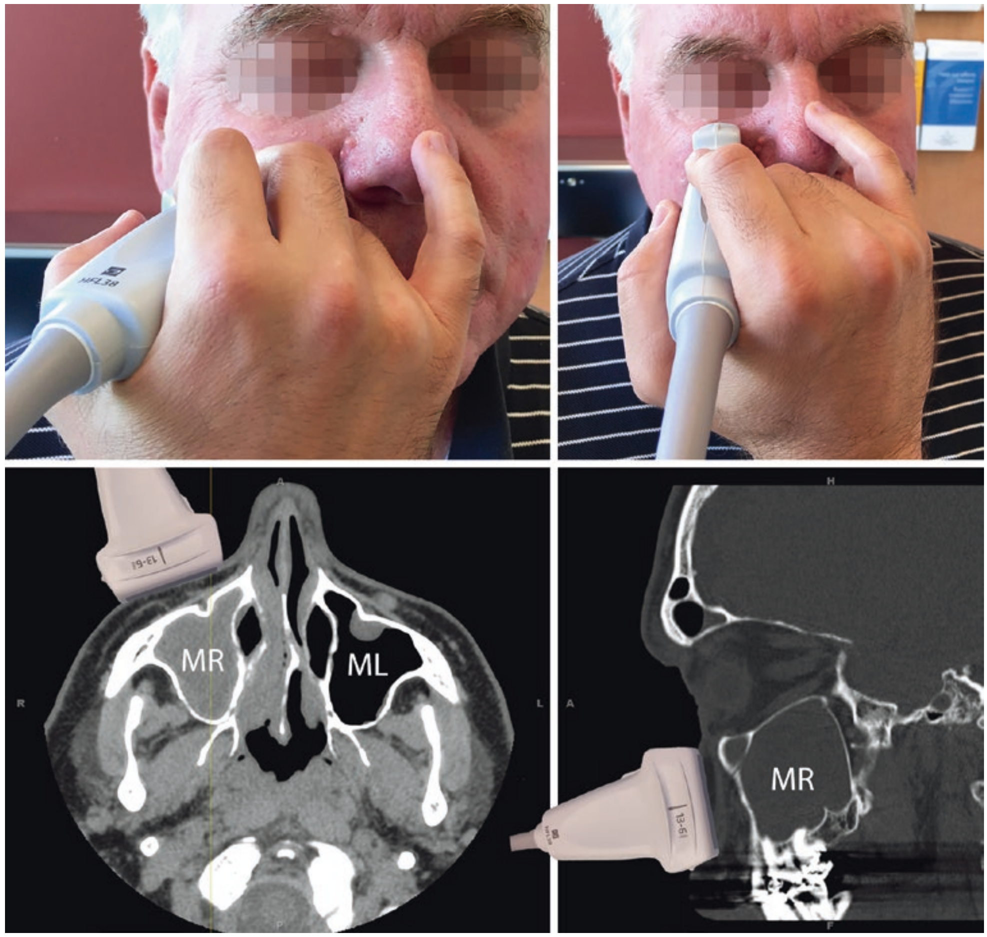

Fig. 9.1 Right maxillary transverse and parasagittal probe positions with CT correlates: a linear probe, musculoskeletal exam preset when available, is used with the indicator to the sitting patient's right for transverse imaging or cephalad for parasagittal imaging of the maxillary sinus. The depth setting is 6 cm. With the right hand, a top and bottom grip is used, anchoring the little finger on the patient's nose. Transverse view is begun at the bottom of the nose, rocking medially a modest amount (so the cord end of the probe moves toward the ear). The parasagittal view is just lateral to the nose, rocking the probe slightly cephalad (so the cord end of the probe moves toward the chest). Fluid always appears first at the caudal aspect of the sinus when the patient is sitting upright. *MR* maxillary sinus, right, *ML* maxillary sinus, left

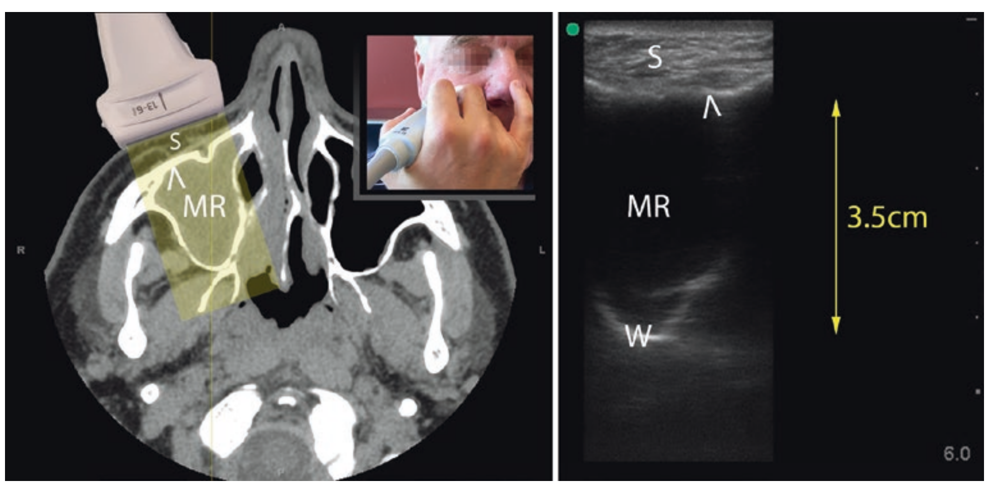

Fig. 9.2 Right maxillary sinus abnormal CT and transverse ultrasound: The right maxillary sinus (MR) is fully opacified. The "V" or "U" shaped back wall (W) is the distinctive appearance in the transverse view and is easily distinguished from reverberation artifact of the anterior sinus wall seen in a normal air-filled sinus. The back wall (W) is almost always at least 2.75 cm from the front wall in adults. ^ anterior maxillary sinus wall, *S* facial soft tissue

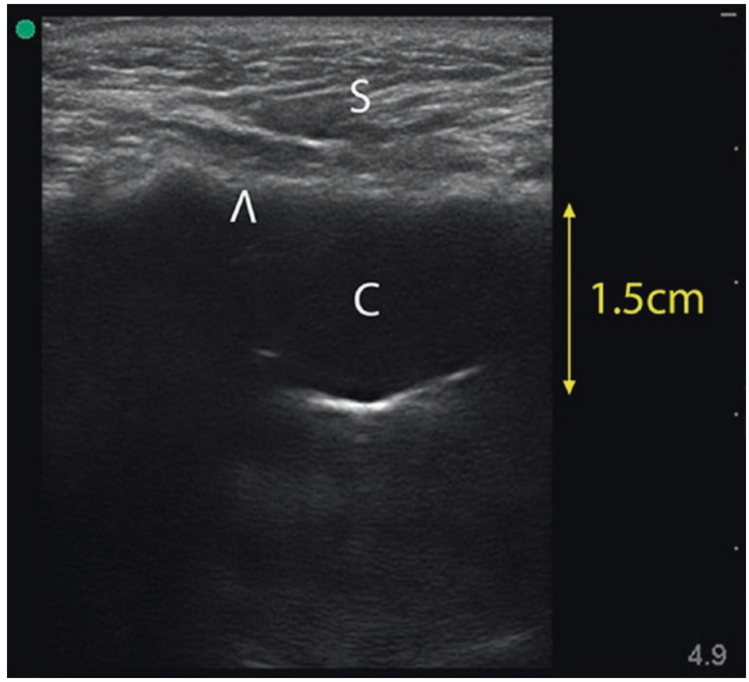

Fig. 9.3 Sinus retention cyst: Sinus retention cysts (C) occur and are distinguished from free fluid by being localized hyperechoic lines, and not usually having the typical V-shaped appearance or depth (only 1.5 cm from the front wall in this example) of the maxillary sinus back wall. They are differentiated from reverberation artifact seen in the air-filled sinus because their shape does not match that of the anterior sinus wall. ^ anterior maxillary sinus wall, *S* facial soft tissue

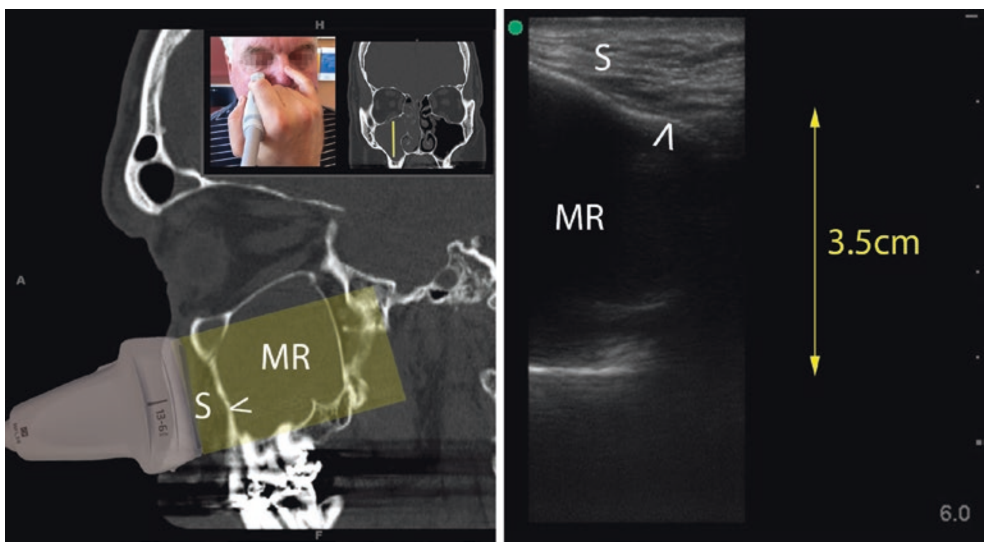

Fig. 9.4 Abnormal right maxillary sinus (MR) CT and parasagittal ultrasound: The back wall (W) in the parasagittal view is a horizontal line, and the length of this line corresponds with the height of the fluid level in the sinus. Note that the back wall (W) is not parallel to the anterior wall (^) of the sinus, helping differentiate it from reverberation artifact of the anterior sinus wall in a normal air-filled sinus. *S* facial soft tissue

Fig. 9.5 Left maxillary sinus transverse and parasagittal probe positions: the right-hand grip on the probe changes to a medial/lateral grip with the little finger anchoring on the patient's cheek

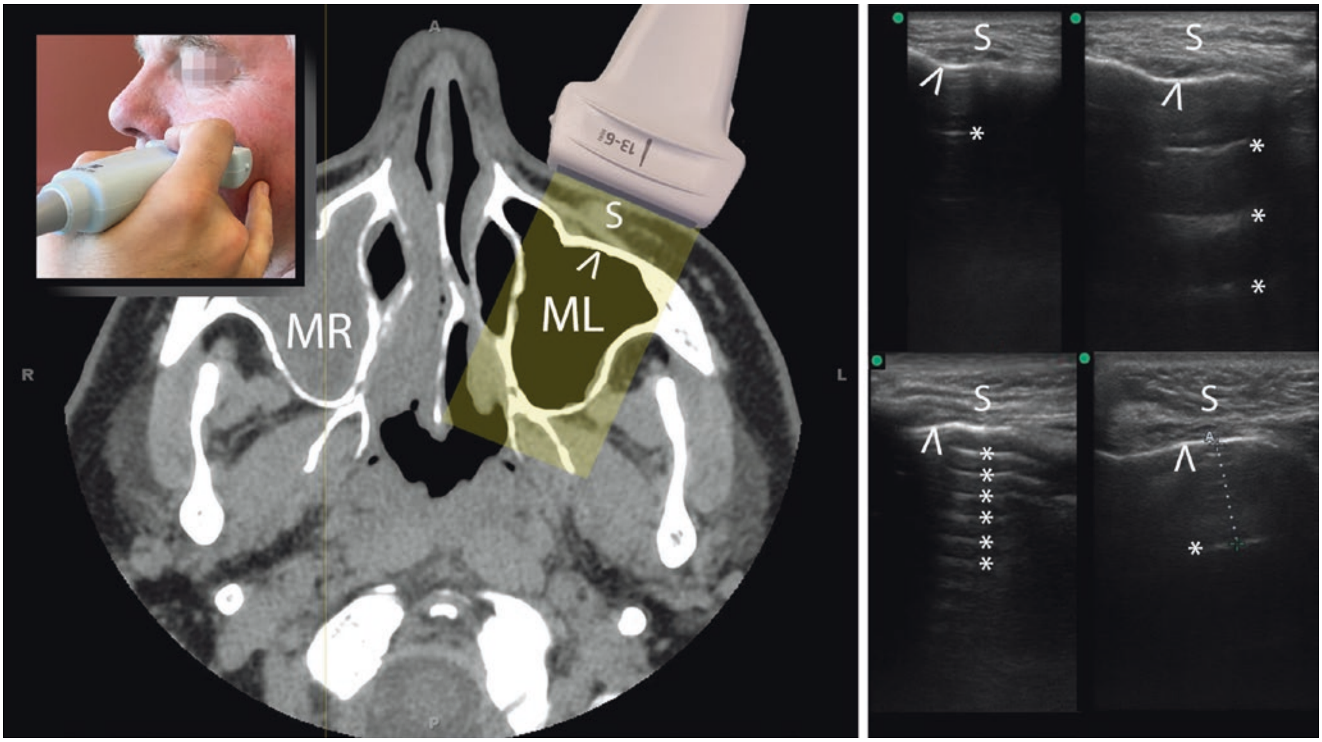

Fig. 9.6 Normal left maxillary sinus (ML) transverse ultrasound variation with CT reference: Only the anterior wall (^) resulting in partial acoustic shadowing with minimal reverberation artifact (*) may be seen (upper left ultrasound image), but reverberation artifact (similar to "A-lines" in normal lung) may be more prominent (upper right, lower left). A single visible reverberation artifact of the anterior sinus wall (lower right) may look like marked thickening of the mucosa or the posterior wall of the sinus; however, it is not deep enough (1.4 cm from front sinus wall) to be the posterior wall of the sinus and is parallel to the anterior wall. *S* facial soft tissue, *MR* maxillary sinus, right

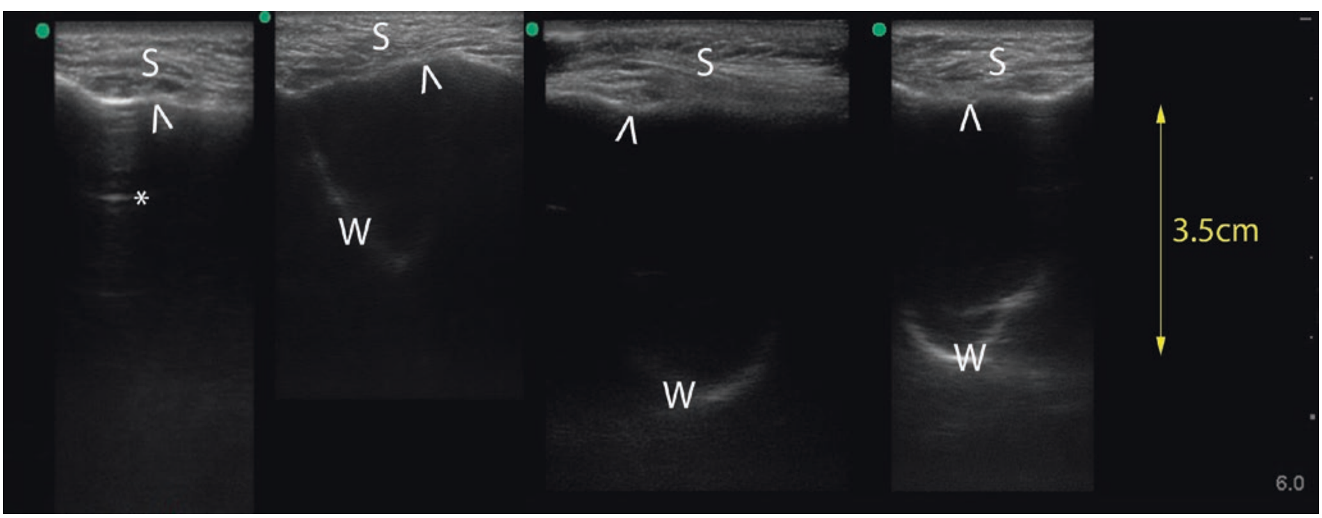

Fig. 9.7 Spectrum of transverse maxillary sinus ultrasound findings: Here is the spectrum of transverse maxillary sinus ultrasound findings with *normal*, air-filled sinus on the left and *strongly positive* fluid-filled sinus on the right. The middle two images are *weakly positive* results seen with smaller amounts of fluid. In these middle two images, the back wall (W) is fainter and only part of the wall may be visualized. This may lead to different treatment decisions than strongly positive results, depending on the rest of the clinical information. *S* facial soft tissue, ^ anterior maxillary sinus wall, *asterisk* reverberation artifact

9.1.1 Skull

Point-of-care ultrasound of the skull has largely been focused on diagnosing skull fractures indicating underlying traumatic brain injury (TBI), rather than other non-traumatic skull pathologic states. Brain injury in adults and children accounts for many visits to emergency departments and clinics annually. In pediatric patients, the presence of a skull fracture is of particular importance given its high association with TBI.

Currently, the standard for diagnosing skull fractures and evaluating for underlying pathology is CT imaging. Radiographs have proven to be of limited use in adults since the sensitivity is approximately five percent. Point-of-care ultrasound for skull fractures, as an indicator of clinically significant brain injury, has not yet been widely incorporated into clinical practice; however, studies suggest that this tool warrants further investigation. Skull ultrasound is thought of as more useful in pediatric than in adult patients. One widely used tool, the Pediatric Emergency Care Applied Research Network (PECARN) decision rule, helps guide whether to obtain CT brain imaging in children, and limit radiation exposure, while focusing CT imaging for clinically important TBIs. Given that ultrasound enables diagnosis of many types of fractures in children and young adults [6], many have looked at whether clinicians are able to use ultrasound for diagnosing skull fractures. Rabiner et al. found that point-of-care ultrasound in children and young adults less than 21 years old, with a median age of 6.4 years, was 88% sensitive and 97% specific in detecting skull fractures [7]. In the future, point-of-care ultrasound for skull fractures may be incorporated into important decision rules in order to decrease radiation exposure and increase the sensitivity of detecting TBI.

See Figs. 9.8 and 9.9 for additional details.

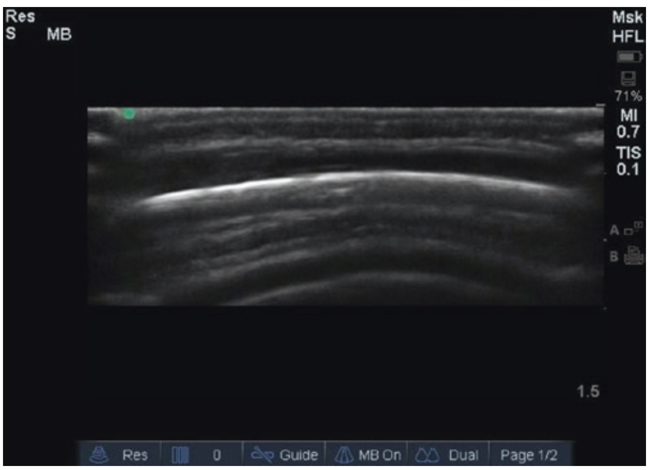

Fig. 9.8 Normal pediatric skull imaged with a linear transducer in a systematic fashion in both sagittal and transverse views. The probe indicator should be placed cephalad and the region of interest should be scanned. The probe should then be rotated 90° for the transverse views with the indicator pointing to the patient's right. Image courtesy of Stephanie Doniger

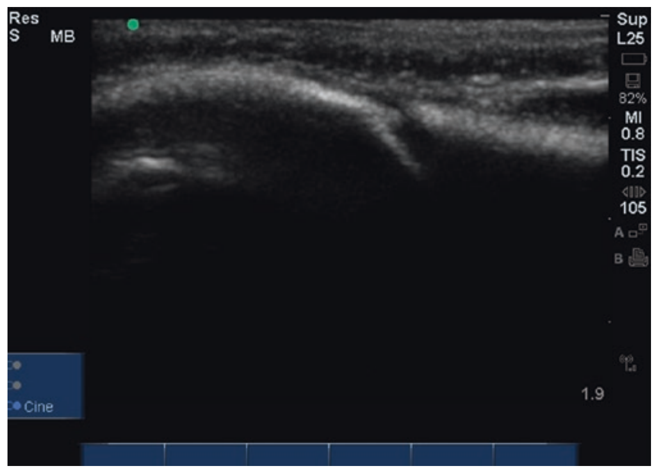

Fig. 9.9 The linear probe is placed over the region of interest, in this case a scalp hematoma, and scanned in two orientations to assess for skull fracture. As you can see, there is a skull fracture present. Image courtesy of Stephanie Doniger

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