White Paper

High frequency ultrasound in MSK

Visualization of the bicipital aponeurosis

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Creativity in Healthcare

The XHF, eXtreme High Frequency Imaging, offers very detailed and precise representation of superficial structures. This technology makes it possible to visualize the Bicipital Aponeurosis using suitable high-resolution, high-quality linear probes.

Prof. Bernhard Moriggl, MD, University of Innsbruck, Austria

Functional Anatomy of the Bicipital Aponeurosis (BA) and clinical background

The biceps brachii muscle (BM) is attached distally to the radial tuberosity via the strong biceps tendon (BT) and to the antebrachial fascia via the ***BA***, also known as "***Lacertus fibrosus***". The latter may be regarded as the fascial expansion of the BT that finally reaches as far as to the posterior margin of the ulna[1]! Comparable expansions are present at different muscles throughout the body and their common functional significance is force transmission between adjacent muscles and force transmission to "non-muscular tissue"[2]. In doing so, the BA supports flexion of the elbow on the one hand and, by stabilizing the BT distally, reduces stress concentration at the BT enthesis[3]. Moreover, the BA increases the effectiveness of the BM as a supinator as it tensions the deep antebrachial fascia[4]. The important but often disregarded functional role of the BA is also reflected by the clinical observation that retraction of a ruptured BT is more striking in case the BA is ruptured too[5]. It has also been reported that a ruptured BA may be accompanied by BT-elongation with a weakening of both, elbow flexion and supination[6]. One may hypothesize two patterns of underlying pathogenesis: a previously injured but healed BT with secondary ruptured BA or a primary ruptured BA with secondary elongated BT. Whatever the case, such observations outline the *functional importance of the BA* by all means.

Despite the well known difficulties of reliable Ultrasound (US) examination of the BT, it has extensively been used to evaluate the tendon's normal and pathologic status. Quite in contrast and considering the above mentioned functional impact of the BA, it is surprising that we lack reports on US-evaluation of this second BM distal attachment. Reasons may be thinness of this structure and its most superficial location that would equally require procedural skills and excellent high-resolution transducers. Some authors even state that US is unable to depict the normal status (and consecutively any direct signs of rupture) of the BA[5,7]. This was reason enough for trying to proof the contrary.

Materials and Methods (a briefing)

The investigation was performed in 100 Volunteers (50 men, 50 women) aged 18-28. The BMI was 22.9 ± 3.0 kg/m^2. All scans were done using a 18-6 MHz linear transducer (LA435; system MyLab25 by Esaote, Genoa, Italy) utilizing the highest frequency. The BA was scanned in two planes: for the first one the transducer was placed in line with the assumed aponeurosis' main bundle (obliquely from the palpable BT proximally towards the upper part of the dorsal border of ulna distally). For the second plane the probe was turned 90 degrees (perpendicular to plane 1) at two different levels (see and compare Figs 2 and 3). In each proband, scanning was done with and without isometric contraction of the BM. In each plane, a second image was gained with color coded Duplex sonography to additionally document the brachial artery that regularly runs deep to the BA.

Results

We could identify the BA in both planes in all subjects investigated. The BA was characterized by two clearly distinguishable white lines enveloping a hypoechoic band (see Figures 1 to 3).

Fig 1 Bicipital aponeurosis (BA) longitudinal view. The BA (arrowheads) is seen as double contour emerging from the myotendineous junction of biceps brachii muscle (arrow), bridging the brachial artery (red dashed oval) and connecting to the antebrachial fascia that covers the pronator teres muscle (open arrow). Note that the BA is clearly distinguishable from the subcutis (asterisks)! BR brachialis muscle.

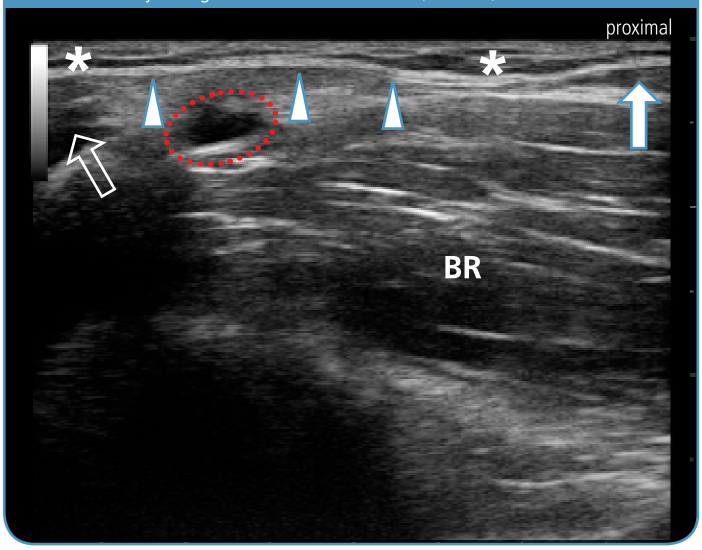


Fig 2 Bicipital aponeurosis (BA) transverse view. The BA (arrowheads) is seen as double contour bridging the brachial artery (red dashed oval) and the median nerve (open yellow arrow) before it connects to the antebrachial fascia that covers the pronator teres muscle (open arrow). Note that, due to anisotropy, the biceps tendon is not delineated here in contrast to Fig 3. BR brachialis muscle.

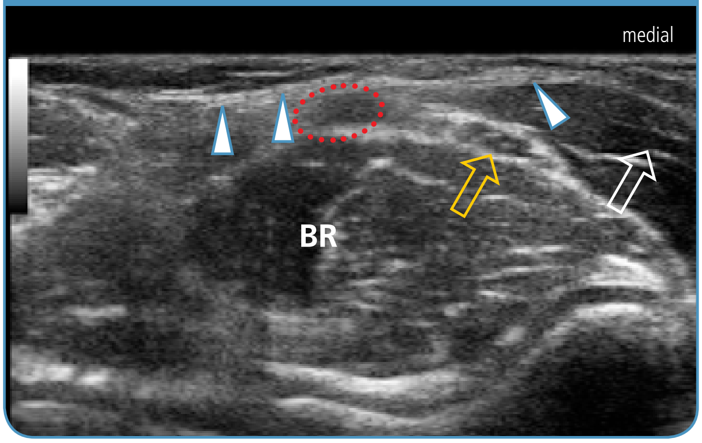
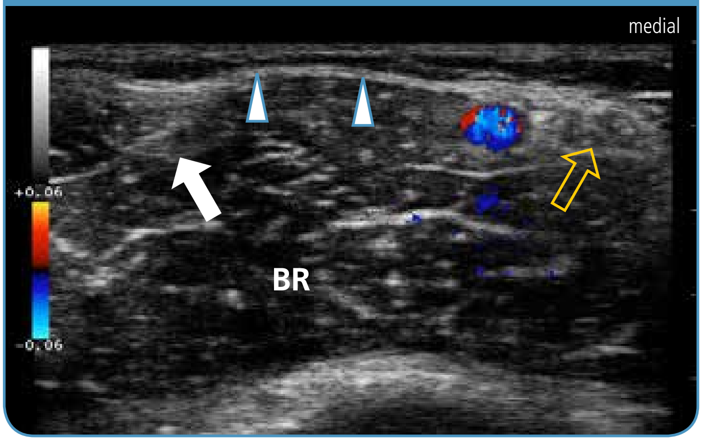


Fig 3 Bicipital aponeurosis (BA) transverse view more proximal compared to Fig 2! The BA (arrowheads) is seen as double contour bridging the brachial artery (colored mainly blue) and the median nerve (open yellow arrow). Note that the BA appears slightly arched. BR brachialis muscle; the biceps tendon (arrow) is partially seen.



The BA spanned the brachial artery (Figure 3) and the median nerve in all subjects. In almost all probands (97/100), the BA was best distinguishable during isometric contraction of the BM. The two parallel layers of the BA appeared slightly arched and faded into the antebrachial fascia in both planes imaged. In all longitudinal images, the BA was clearly seen arising from the BM belly, the BT or the myotendineous junction, respectively (Figure 1). Due to the obvious sparseness of the BA (taking the scale of the system as reference it was obvious that "thickness" was always less than 1 mm!), no measurements were taken (inherent measurement errors would have lead to unacceptable pseudo accurateness).

Discussion and Conclusion

In contrast to previous reports (see above), imaging of the BA is possible using suitable high-resolution, high-quality linear probes. It goes without saying that appropriate experience in scanning the MSK system is a prerequisite. For a clinical context it is worth mentioning that what is illustrated here as the ***US representation*** of the BA is in fact the *central main part* of that flared out BM insertion. Throughout the cohort, visibility of the BA was best during isometric contraction against resistance. This is important as many of the investigations within the MSK system is done both, at rest and dynamically. With knowledge of the normal ***sono-anatomic appearance*** of the ***BA*** it may be feasible to detect ruptures and/or alterations of that somehow neglected part of the BM's distal attachments. Clearly, this can only be shown in a clinically designed study. Nevertheless it is encouraging to see and document what is possible and we should use all options of the still ongoing rapid technical development for the sake of a more detailed analysis that finally will serve our patients.

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Presented study of
Prof. Bernhard Moriggl, MD,
University of Innsbruck, Austria

Prof. Bernhard Moriggl, MD, FIACA, is a staff member and professor of anatomy at the Innsbruck Medical University, Austria. He has worked out several cooperations for improvements in teaching and improving regional anaesthesia techniques. He has special knowledge of small-parts sonography and sonomorphology. Moreover, he is one of the founding fathers of the SIG USPM (ultrasonography in pain medicine) within the ASRA and is its educational officer.

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Esaote S.p.A.

Via di Caciolle 15 - 50127 Florence, Italy - Tel. +39 055 4229 1 - Fax +39 055 4229 208 - international.sales@esaote.com - www.esaote.com
Via A. Siffredi, 58 16153 Genoa, Italy, Tel. +39 010 6547 1, Fax +39 010 6547 275, info@esaote.com