

Research article - Human anatomy case report

Abnormal branching of the axillary artery: an axillo-hepatic artery

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Abstract

The axillary artery is a continuation of the subclavian at the outer border of first rib. Reports of anatomic variations of the axillary artery encountered during cadaveric dissection are not uncommon. However, abnormal branching patterns of the axillary artery identified on imaging studies are rare. We encountered an abnormal branch of the right axillary artery, which descended along the lateral thoraco-abdominal wall and gave off branches to the liver capsule before terminating at the level of the ipsilateral iliac crest. Knowledge of this variation, which we term the axillo-hepatic artery, will be of interest to anatomists, radiologists and adult- and pediatric- surgeons operating on the upper chest and abdominal regions. To our knowledge, such a vessel has not been reported previously in the extant medical literature.

Key words

Axillary artery, axillo-hepatic artery, abnormal branching, variation, thoraco-abdominal artery

Introduction

The length of the subclavian artery beyond the lateral border of first rib up to the lateral border of the teres major muscle is defined as the axillary artery (AA) in standard descriptions of upper limb arterial anatomy (Standring, 2008). Due to advances and increase in number of interventional cardiovascular procedures, the AA is now identified as an artery of increasing clinical significance for vascular access. Additionally, the AA is also of interest to orthopedic, cardiothoracic-, plastic and general surgeons operating in the upper thoracic region in patients of all age groups (Astik and Dave, 2012; Ravi et al., 2012; Hwang et al., 2013). Cadaveric reports of anatomic variations involving the AA have been frequently reported, however abnormal branching patterns of the AA diagnosed on imaging studies have rarely been reported (Sato and Takafuji, 1992; Kogan and Lewinson, 1998; Cavdar et al., 2000; Ravi et al., 2012). We report a case of a 13-month-old adolescent male who was found to have an abnormally high split of his right axillary artery, which descended along the lateral thoraco-abdominal wall and gave off branches to the liver capsule before abruptly terminating at the level of the right iliac crest.

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Case report

A 13-month-old male child presented to our outpatient clinic with congenital scoliosis. For further evaluation, he underwent a magnetic resonance imaging (MRI) of his chest and abdomen, which revealed a split axillary artery (Figs 1-3). Imaging was by Gadevist (Gadobutrol, Bayer, NJ, USA) contrast enhanced MRI using Ingenia 3.0 Tesla (Philips, Andover, MA, USA). The superficial branch travelled horizontally to assume the normal course of the axillary artery, however a deeper branch descended and travelled along the anterolateral thoraco-abdominal wall. This artery gave off multiple branches to the liver capsule before abruptly terminating at the level of the right iliac crest. In addition to the abnormal branching of the axillary artery, the patient also had an anomalous right-sided aortic arch with a retroesophageal right subclavian artery as well as a right accessory renal artery. The patient also had multiple other associated non-vascular congenital abnormalities (Table 1). No other imaging examination other than the initial MRI was performed to study the course of the variant artery described above. The patient's exam was non-focal with appropriate distal pulses.

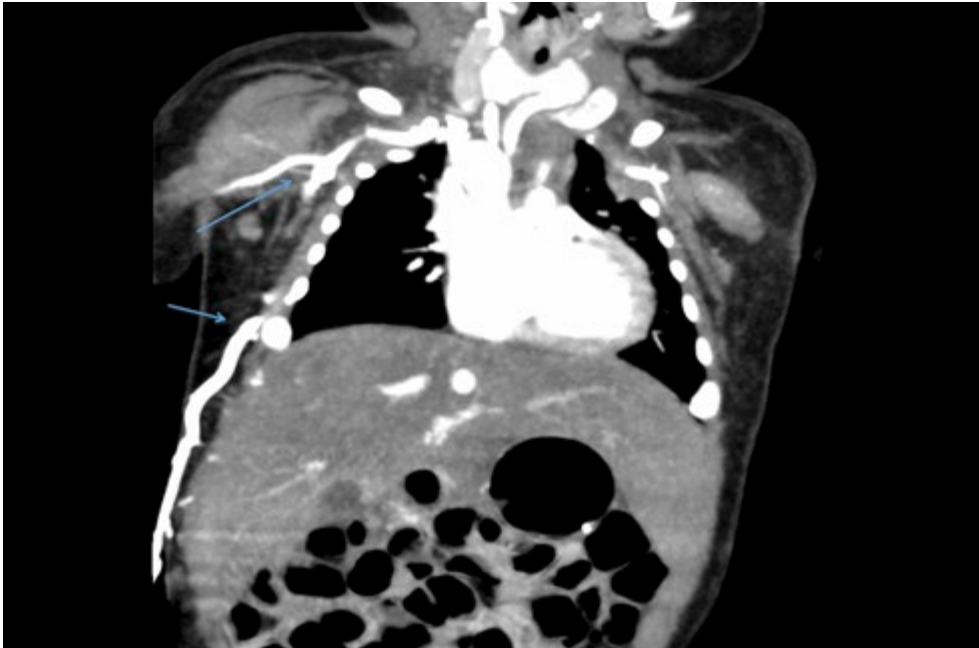


Figure 1 – Coronal magnetic resonance imaging of chest and abdomen by Gadevist (Gadobutrol, Bayer, NJ, USA) contrast enhanced MRI using Ingenia 3.0 Tesla (Philips, Andover, MA, USA), showing the abnormal branching of right axillary artery. The deeper branch is seen descending along the lateral thoraco-abdominal wall.



Figure 2 – Coronal magnetic resonance imaging of chest and abdomen showing thoraco-abdominal artery branching off the right axillary artery.

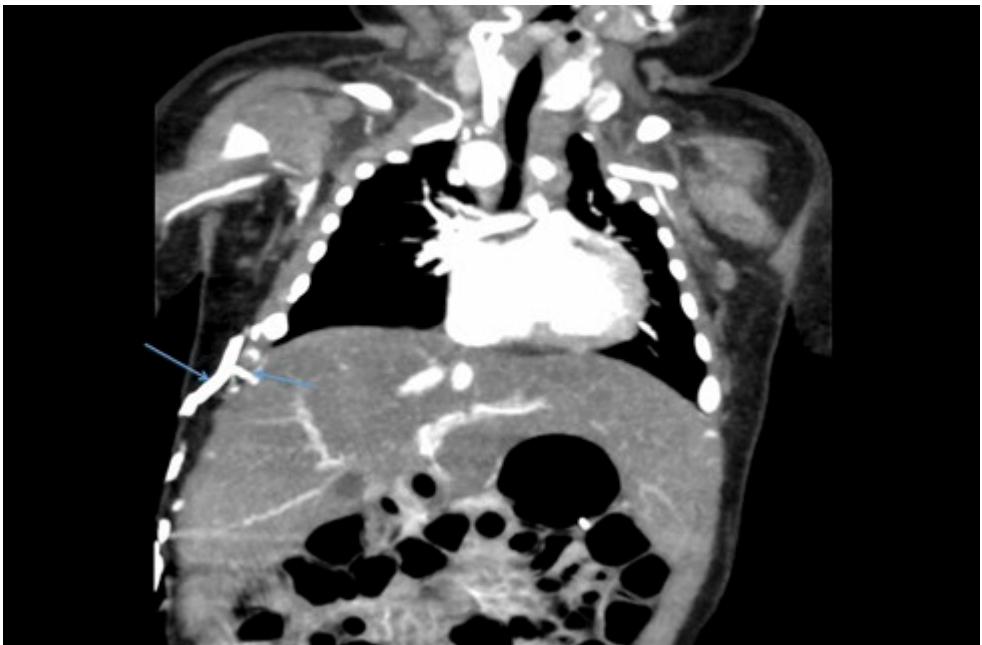


Figure 3 – Coronal magnetic resonance imaging of chest and abdomen contrast enhanced MRI using Ingenia 3.0 Telsa, Philips (Andover, MA, USA) MRI) showing branches off the thoraco-abdominal artery feeding the liver capsule.

Table 1 – Associated congenital anomalies in our patient (vascular malformations in italics).

Micrognathia/ Retrognathia
Cleft palate
Polydactyly
<i>Right sided aortic arch with right retroesophageal subclavian artery</i>
<i>right accessory renal artery</i>
Duplicated right renal collecting system
Right hydronephrosis
Hemivertebra / Butterfly vertebra / Scoliosis
Bilateral hip dislocation
Absent right femur
Conus medullaris termination at L2/L3
Mild hydromyelia

Discussion

Anatomy and Embryology

Embryologically, multiple theories have been proposed regarding the upper limb arterial origin. The most recent theory from the last decade suggests that the arterial system of the upper limb develops by selective enlargement or regression of a capillary plexus and not by budding from a main axial trunk and this development is closely related to bone development (Rodriguez-Niedenfuhr et al., 2001; Natsis et al., 2014). In contrast, another theory suggests that only one upper limb arterial bud (subclavian) persists, which continues to form axillary and brachial arteries, which supply the lateral thorax as well as the upper limb (Kogan and Lewinson, 1998). An arrest or defect in the embryonic development of the vascular plexuses of the upper limb buds is thought to play a role in development of variations in the arterial origins and courses of the major upper limb vessels (Cavdar et al., 2000).

In standard anatomic texts, the AA is described as the continuation of the ipsilateral subclavian artery at the outer border of first rib up to the outer border of the teres major muscle, beyond that point it continues in the arm as the brachial artery (Standring, 2008). In relation to the pectoralis minor muscle, the course of the AA is divided into three parts - the proximal (1st), posterior (2nd) and distal (3rd) (Standring, 2008). Six major branches are given off the axillary artery, namely superior thoracic, thoracoacromial, lateral thoracic, subscapular, and anterior and posterior circumflex humeral (Standring, 2008).

Anatomic variations of upper extremity arteries are not rare. In a study of 100 upper extremity arteriograms, a 9% incidence of arterial variations involving the upper extremity vessels was identified (Uglietta and Kadir, 1989). The overall incidence of these anomalies in the upper extremity is estimated to be as high as 24%

(Cavdar et al., 2000). Additionally, branching variations involving the AA are also not uncommon (Astik and Dave, 2012). However, there are only a limited number of reports describing branching patterns similar to our case report: none of these reports has the same unique branching pattern with axillo-hepatic branches, as seen in our case (Sato and Takafuji, 1992; Kogan and Lewinson, 1998; Ravi et al., 2012). In a previous study by Sato and Takafuji (1992) a branch of the AA supplying the abdominal part of the pectoralis major muscle was mentioned. The authors named this branch as *arteria partis abdominalis* (Sato and Takafuji, 1992). Another report mentioned a "thoraco-epigastric" branch of the AA, which descended on the anterior aspect of the axillary fossa and anastomosed with the superficial epigastric artery in the hypogastric region (Kogan and Lewinson, 1998). In another cadaveric study, one of the two branches off the second part of the AA was designated as an axillo-thoracic artery (Ravi et al., 2012). In contrast, in our case, an additional branch off the right AA descended along the lateral thoraco-abdominal wall and gave off branches to the liver capsule before abruptly terminating at the level of the right iliac crest (Figs 1-3). Our review of reports in the extant literature did not find any cases mentioning a similar abnormal branching pattern.

Numerous other branching variations involving the AA are also reported (Cavdar et al., 2000; Astik and Dave, 2012). In another cadaveric report, a high division of the AA into superficial and deep brachial arteries without any mention of thoraco-abdominal branching was reported (Cavdar et al., 2000). In a cadaveric study of 80 limbs, the authors reported that the AA variations were found in 62.5% limbs (Astik and Dave, 2012). The variations included a lateral thoracic artery originating from the subscapular artery; absent thoracoacromial trunk, or its branches arising directly from the second part of the axillary artery; division of the thoracoacromial trunk into deltoacromial and clavipectoral trunks, which were further divided into all the branches of the thoracoacromial trunk; origin of subscapular, anterior circumflex humeral, posterior circumflex humeral and profunda brachii arteries from a common trunk from the third part of the axillary artery; and an origin of the posterior circumflex humeral artery from brachial artery in addition to third part of the axillary artery (Astik and Dave, 2012). There was no mention of an abnormal thoraco-abdominal branch similar to the one seen in our case. In another cadaveric report, bifurcation of second part of AA into superficial and deep brachial arteries has also been reported (Cavdar et al., 2000; Natsis et al., 2014).

In contrast to our report, cadaveric reports describing various branching variations of the AA are able to provide a detailed anatomical description of the course of the variant branch (Kogan and Lewinson, 1998; Cavdar et al., 2000; Astik and Dave, 2012). However, we encountered this variant branch in our patient on MRI, and since no other vascular imaging was obtained to further characterize this variation, we are unable to provide a more detailed anatomic description of this abnormal branch of the AA in terms of the caliber of the vessel, other abnormal branches not visible on the MRI or presence of any aneurysms or other structural defects in the vessel wall.

Clinical Correlation

Knowledge of the normal anatomy as well as variations of AA is significant in multiple clinical interventions and procedures. Cardiothoracic surgeons utilize the AA during antegrade cerebral perfusion in aortic surgery in high risk patients. The

AA is also being increasingly used as the access vessel for invasive cardiovascular procedures. Orthopedic surgeons encounter the axillary artery while dealing with brachial plexus repairs or during surgical intervention of shoulder dislocations or proximal humeral fractures (Astik and Dave, 2012). Trauma and general surgeons deal with the AA during axillary reconstruction or while treating AA hematoma after trauma, and during radical mastectomy (Ravi et al., 2012). Vascular surgeons and vascular radiologists cannulate the AA for several procedures or while treating the AA thrombosis or AA aneurysm (Astik and Dave, 2012). The AA is also important to plastic surgeons performing a musculocutaneous flap for wound or defect reconstruction or during harvesting the AA for microvascular graft to repair damaged arteries (Hwang et al., 2013). In particular, the variation found in our patient might be significant to the hepato-biliary surgeon due to the presence of the hepatic branches off the variant axillary artery branch. When pre-operative angiogram is available, these variant branching patterns can be potentially identified, however, we recommend that surgeons operating in this region be mindful of this abnormal branching pattern when pre-operative imaging is not available or in emergency situations such as trauma patients so as to be well-equipped to deal with any hemorrhagic complications arising due to such unpredictable branching of the AA.

In conclusion, awareness of this variation involving an abnormal branching of right axillary artery into a thoraco-abdominal artery with branches to liver capsule is not only interesting to anatomists but also to radiologists and interventional cardiologists who frequently use the AA as a vascular access for invasive procedures. It is also of clinical interest to orthopedic, cardiothoracic, plastic, vascular and general surgeons operating on thoraco-abdominal and proximal shoulder girdle regions in patients of all age groups. Anatomical variations involving AA should be reported as discovered in view of their potential clinical and anatomical importance.

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