Arch. Biol. Sci., Belgrade, 63 (3), 641-648, 2011 DOI:10.2298/ABS1103641K

A CASE OF A DOUBLE VARIANT OF THE ARTERIAL SYSTEM IN THE UPPER EXTREMITY: *ARTERIA BRACHIALIS ACCESSORIA ET ARTERIA COMITANS NERVI MEDIANI*

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Abstract - A thorough knowledge of arteries of the upper extremity is necessary for catheterization, graft harvesting, shunt application, and Astrup's examination. Coincidences of two different variants are rather rare. We present a case of the coincidental presence of *arteria brachialis accessoria* stemming from the *arteria axillaris* and reuniting with the *arteria brachialis* 1.5cm below the origin of the *arteria collateralis ulnaris inferior*; and *arteria comitans nervi median* originated in association with the *arteria interossea communis* from the *arteria ulnaris*, passing into the palm and towards the *arteriae digitales palmares* to the thumb, index and lateral side of the third finger. Such coincidence has never been reported before.

Key words: Anatomical variant; accessory brachial artery; median artery; coincidence

UDC 616.13

INTRODUCTION

Variations of the arterial system of the upper extremity are very common, even surpassing the textbook normotype in the axillary region. They are present in 10-55% of cases (De Garis, 1928; Trotter, 1930; Lippert, 1985; Konarik, 2010), reaching 23% of cases in the free part of the limb (Valsecchi, 2006). The incidence of accessory brachial artery (*arteria brachialis accessoria*, ABA) is constantly reported in between 0.13 and 1.5% of cases (Green, 1830; Quain, 1844; Tiedemann, 1831; Maestre, 1864; Henle, 1868; Ruge, 1884; Herrington, 1905; Poynter, 1922; Hazlett, 1949; McCormack, 1953; Weathersby, 1956; Keen, 1961; Jurjus, 1986; Rodríguez-Niedenführ, 2001a) (for detailed numbers see Table 1). The incidence of the median artery (*arteria comitans nervi mediani*, MA – according to Terminologia Anatomica 1998) varies greatly - from 1.5-50%, depending on the definition of the MA (Henneberg, 1995; Rodríguez-Niedenführ, 1999, FCAT, 1998). Bergman (1992-2004) stated in his internet encyclopedia that the incidence was on average about 8%. Rodríguez-Niedenführ et al. (1999) observed AM in 18.7% of fetuses and in 12% of adults in his detailed and thorough studies data collected from previous authors (Kachlik, 2010).

However, the coincidence of two variants is less usual and the relevant data are almost always missing. The coincidental presence of the ABA in the arm and MA in the forearm and hand which are observed during a routine dissection, has never been reported, because the combinations of these variations have not been properly investigated so far. Such variations can have severe clinical consequences. The ABA can serve as a route for a catheter during the radial ap-

proach to coronary procedures using catheterization. If ABA is present, it is often hypoplastic and stenotic, either in a part or along its whole course, and the danger that the catheter might stop during the diagnostic or therapeutic procedure is high. The MA can replace the radial or ulnar artery. Both can be hypoplastic and stenotic, in part or along the whole course, or just a bit narrow. This can lead to failure of the catheterization when using either the radial or ulnar artery approach. The MA can serve as collateral for the hand in cases when the radial or ulnar arteries are used as a vascular pedicle for a forearm flap or for a coronary bypass graft (Burzotta, 2009; Kachlik, 2010).

The terminology in this article strictly follows that published in the Terminologia Anatomica (FCAT, 1998), as reviewed in our previous article (Kachlik, 2008), and as suggested by Rodríguez-Niedenführ et al. (2001b).

MATERIALS AND METHODS

The body of an 88-year-old man, fixed with the formaldehyde method, was routinely dissected at the Department of Anatomy, Medical Faculty of Hradec Králové, Charles University in Prague. Both upper limbs were carefully cleaned and two independent vascular variations were observed and documented.

RESULTS

The ABA in the right upper limb originated from the axillary artery (*arteria axillaris*) 1.5 cm proximally to the origin of the posterior circumflex humeral artery (*arteria circumflexa humeri posterior*), descended along the arm and rejoined the brachial artery (*arteria brachialis*, BA) within the medial bicipital groove (*sulcus bicipitalis medialis*), approximately 1.5 cm distally to the origin of the inferior collateral ulnar artery (*arteria collateralis ulnaris inferior*) (see Fig. 1). The total length of the ABA was 18.5 cm and its outer diameter was 5 mm at the beginning and 4 mm at the termination point. The ABA descended deeply, along the arm and parallel to the BA. Both arteries were separated by the median nerve (*nervus medianus*). The ABA crossed the median nerve ventrally, 3.5 cm from its origin, sending off the anterior circumflex humeral artery (*arteria circumflexa humeri anterior*) and further along the arm, two other larger muscular branches (with a diameter of at least 1 mm) that supply the biceps brachii (*musculus biceps brachii*), stemming 8 cm and 12.5 cm from the ABA origin.

The BA that ran deeper in the septum was crossed ventrally by the median nerve. It gave off typical branches, mainly the muscular branch for the biceps brachii that was just proximal to the reunion site of both arterial trunks. The outer diameter of the BA was 7 mm after it branched the ABA, and 5 mm at the BA termination. The outer diameter of the axillary artery (*arteria axillaris*), just proximal to the bifurcation into BA and ABA, was 10 mm and that of the reunited stem of BA in the arm was 6 mm.

Both arterial trunks featured their accompanying veins which after having entered the axillary fossa (*fossa axillaris*), successively united and received the concomitant basilic vein (*vena basilica*) into one typical axillary vein (*vena axillaris*).

No other variations, aberrant arteries or their courses were observed in the arm.

The second variation of the median artery (*arteria comitans nervi mediani*), stemmed from the ulnar artery (*arteria ulnaris*) together with the common interosseous artery (*arteria interossea communis*). Macroscopically, this branching pattern had the appearance of a trifurcation. The common interosseous artery merged into the forearm depth and after 1 cm it typically bifurcated into the anterior and posterior interosseous arteries (*arteria interossea anterior et posterior*). The MA descended along the forearm in the layer with the median nerve and sent off a many small muscular branches for the anterior group of the forearm muscles (flexors). Then it passed the carpal tunnel (*canalis carpi*), firmly attached to the median nerve, and in the hand gave off the palmar digital arteries (*arteriae digitales palmares*) for the thumb, index and lateral side of the third digit. The branch heading towards the first intermetacarpal

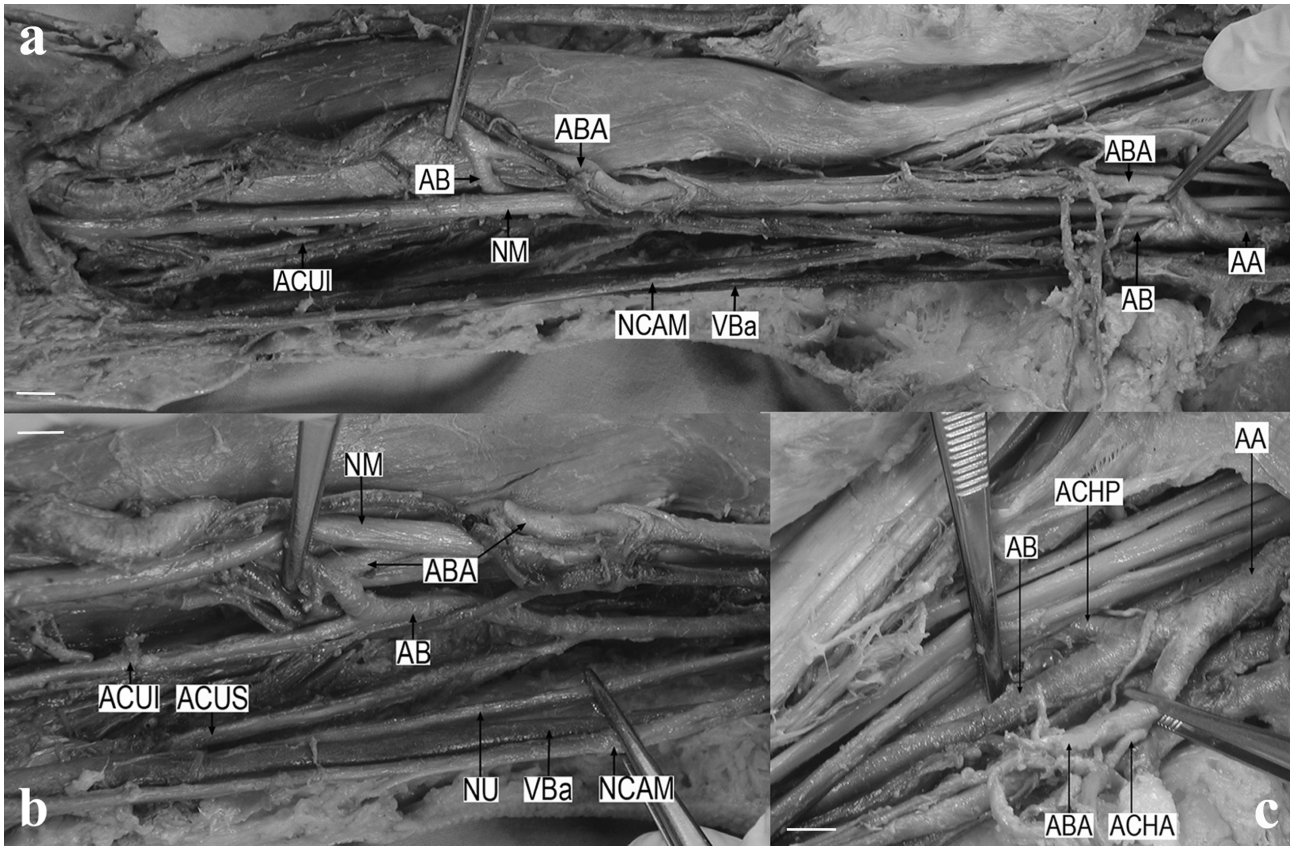

Fig. 1 The accessory brachial artery (ABA) – right upper limb, ventral aspect
1a – Overview of the ABA course. 1b – Detail in the arm. 1c – Detail in the axillary fossa. Bar – 1 cm.

Legend: AA – *arteria axillaris*, AB – *arteria brachialis*, ABA – *arteria brachialis accessoria*, ACHA – *arteria circumflexa humeri anterior*, ACHP – *arteria circumflexa humeri posterior*, ACUI – *arteria collateralis ulnaris inferior*, ACUS – *arteria collateralis ulnaris superior*, NCAM – *nervus cutaneus antebrachii medialis*, NM – *nervus medianus*, NU – *nervus* ulnaris, VBa – *vena basilica*

space passed the first dorsal interosseous muscle (*musculus interosseus dorsalis primus*) distally, and anastomosed widely with the radial artery (*arteria radialis*) (see Figure 2). The MA did not form visible anastomoses with the ulnar artery within the hand. There was no superficial palmar arch (*arcus palmaris superficialis*) in the hand.

The outer diameter of the MA was 2 mm at its origin and 1.5 mm at is termination where it branched into little arteries for the digits. The total length of the MA was 25 cm (ulna beeing 27 cm long). The anastomosis with the radial artery was 2 mm wide, and turned around the first dorsal interosseous muscle. The MA and all of its branches were accompanied by a pair of veins without any visible interconnections.

The schematics of both variants are presented on Fig. 3.

The MA was present identically in both upper limbs, unlike the ABA which was observed on the right side only. The left side featured the normal BA (with an outer diameter of 6 mm). It bifurcated in the cubital fossa (*fossa cubitalis*) into the radial and ulnar arteries (with outer diameters of 4 mm and 5 mm, respectively). The bifurcation was a branching point for the radial and ulnar recurrent arter-

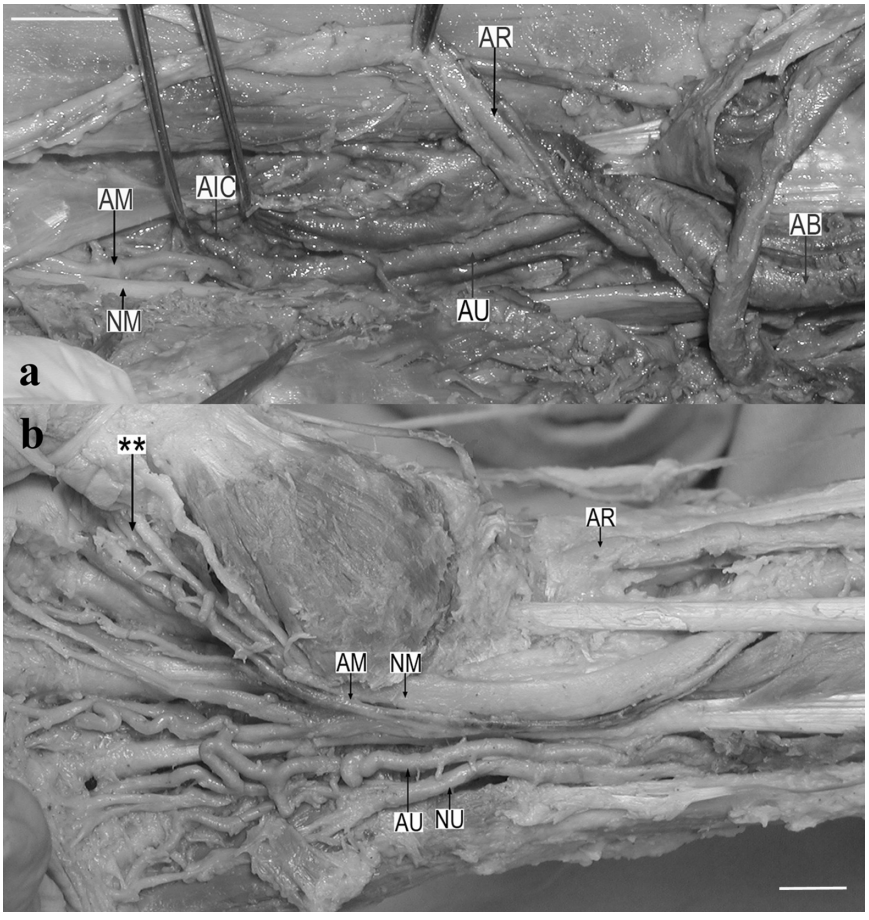

Fig. 2 The median artery (AM) – right upper limb, ventral aspect
1a – Detail in the cubital fossa. 1b – Detail in the wrist and hand. Bar – 1 cm.

Legend: AB – *arteria brachialis*, AIC – *arteria interossea communis*, AM – *arteria comitans nervi mediani*, AR – *arteria radialis*, AU – *arteria ulnaris*, NM – *nervus medianus*, NU – *nervus* ulnaris, ** – anastomosis between AM and AR

ies (*arteria recurrens radialis et ulnaris*). The ulnar artery sent off two thick muscular branches medially (24 mm and 31 mm distal to the bifurcation of the BA) for the flexor of the forearm; it then turned medially. At this curve, it branched off the common interosseous artery (with an outer diameter of 3 mm); it merged gently and laterally into the muscles and the MA which maintained the direction of the ulnar artery (see Figure 4). The MA sent off a thin transverse muscular branch medially (with an outer diameter of 1 mm) 3 mm distally to its origin. Then, it ran along the median nerve, reached the hand and terminated in the same way as described on the right side. The outer diameter of the MA was 2 mm at its origin and 1.5 mm at its termination where it branched into little arteries for the digits. The total length of the MA was 25 cm (ulna been 27 cm long).

DISCUSSION

The term "accessory brachial artery" was first established by McCormack (1953). The ABA is derived from another embryological abnormality, referred to as the superficial brachial artery (*arteria brachialis superficialis* or SBA). The SBA is based on the persistence of more than one intersegmental cervical artery which does not deteriorate but persists and can

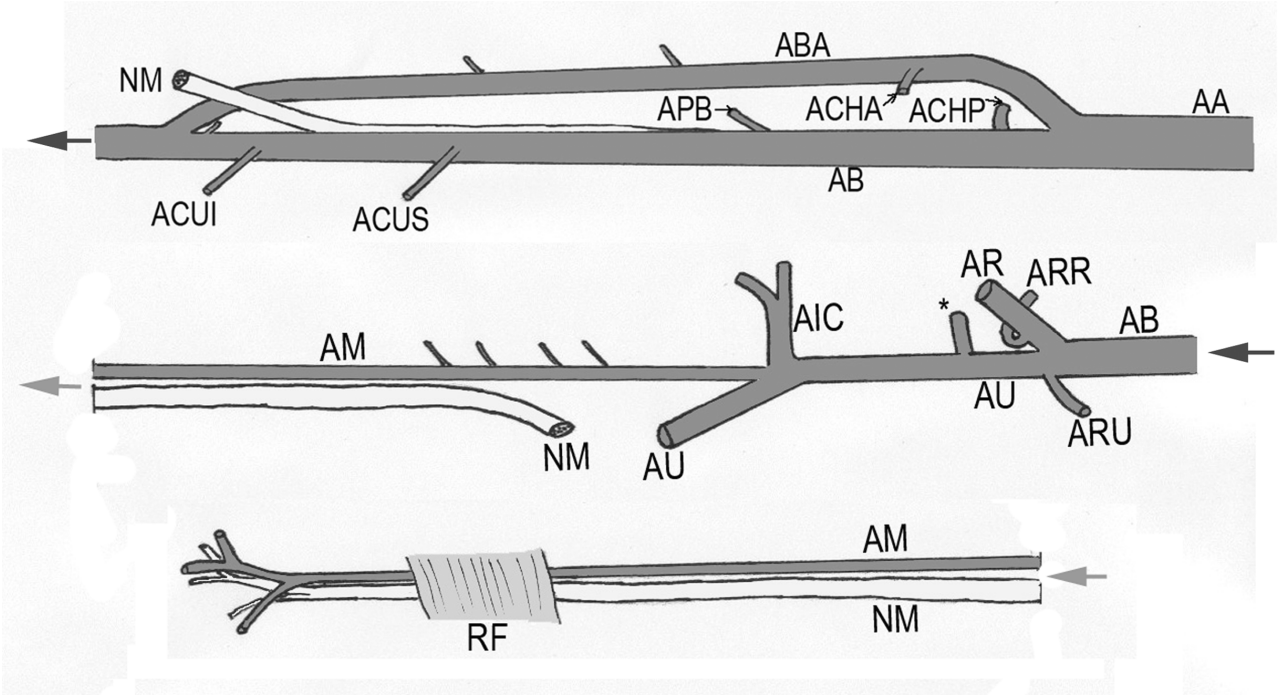

Fig. 3 Schema of the double variant of arterial system in the upper extremity. Bar – 1 cm.

Legend: AA – *arteria axillaris*, AB – *arteria brachialis*, ABA – *arteria brachialis accessoria*, ACHA – *arteria circumflexa humeri anterior*, ACHP – *arteria circumflexa humeri posterior*, ACUI – *arteria collateralis ulnaris inferior*, ACUS – *arteria collateralis ulnaris superior*, AIC – *arteria interossea communis*, AM – arteria mediana, APB – *arteria profunda brachii*, AR – *arteria radialis*, ARR – *arteria recurrens radialis*, ARU – *arteria recurrens ulnaris*, AU – *arteria ulnaris*, NCAM – *nervus cutaneus antebrachii medialis*, NM – *nervus medianus*, NU – *nervus* ulnaris, RF – *retinaculum musculorum flexorum*, * – large muscular branch from AU

even enlarge its diameter (Jurjus, 1986; Evans, 1912). According to Adachi (1928), the SBA is the brachial artery which descends superficially to the median nerve. This definition was changed by Rodríguez-Niedenführ et al. (2001b) who interpreted this variant as running "rather" superficially to the median nerve. For details, see Konarik (2009) and Kachlik (2011).

The first case that has ever been reported in the literature concerning the ABA was published in 1830 by Green (1830) in his book "An Account of the Varieties in the Arterial System of the Human Body", and was soon followed by Quain (1844) in his textbook "Anatomy of the Arteries of the Human Body". Ruge (1884) suggested denominating the ABA as the "*Inselbildung*" ("building of an island") due to the fact that the appearance of stemming and rejoining the brachial artery resembles an island. The first separate case-report of this arterial variant was published by Herrington (1905) who described it as a case of "high bifurcation of the brachial artery with reunion at the elbows". Only seven studies (1844-2001) have mentioned the percentage-frequency of the ABA until now. The incidence of ABA is constantly reported to be between 0.13-1.5% (see Table 1). No data about their diameters, lengths and possible hypoplasticity have been reported until now.

On the other hand, the data describing the incidence of the MA varies considerably. Bergman et al. (1992-2004) stated in his internet encyclopaedia that its average incidence was 8%. In their detailed and thorough study, Rodríguez-Niedenführ et al. (1999) observed MA in 18.7% foetuses and in 12% adults. He strongly recommends to distinguish between the

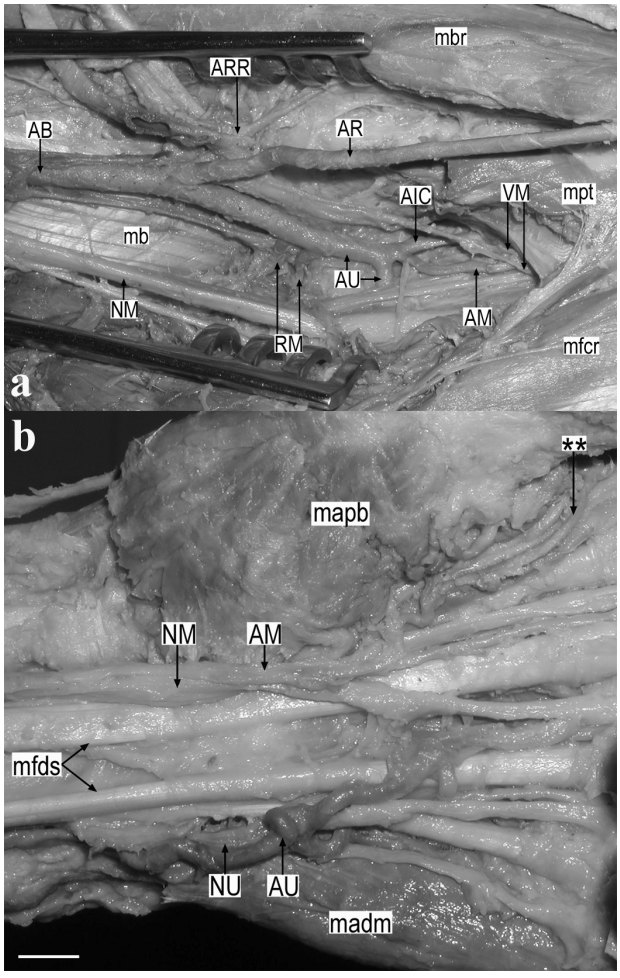

Fig. 4 The median artery (AM) – left upper limb, ventral aspect 1a – Detail in the cubital fossa. 1b – Detail in the wrist and hand. Bar – 1 cm.

Legend: AB – *arteria brachialis*, AIC – *arteria interossea communis*, AM – *arteria comitans nervi mediani*, AR – *arteria radialis*, ARR – *arteria recurrens radialis*, AU – *arteria ulnaris*, madm – *musculus abductor digiti minimi*, mapb – *musculus abductor pollicis brevis,* mb – *musculus brachialis*, mfds – *musculus flexor digitorum superficialis*, mpt – *musculus pronator teres*, mfcr – *musculus flexor carpi radialis*, NM – *nervus medianus*, NU – *nervus* ulnaris, RM – *rami musculares*, VM – *vena mediana,* ** – anastomosis between AM and AR

forearm and palmar type of median artery (*arteria comitans nervi mediani antebrachii* and *arteria comitans nervi mediani manus*). The former type runs along the forearm only and disappears supplying the anterior group of forearm muscles. It is reported to be present in 20% of cases. On the contrary, the latter type passes the carpal tunnel and contributes to the blood supply of the palm and, moreover in 35% of cases, it forms the complete superficial palmar arch joining the trunk of the ulnar artery.

As for its developmental aspects, a new theory by Rodríguez-Niedenführ et al. (2001b) was formulated in 2001. It emphasizes that all the main arterial trunks of the upper limbs are formed from a primitive capillary network encircling the developing bones. This theory can explain all of the reported variants of the upper limb arteries. According to this theory and the findings published by Rodríguez-Niedenführ et al. (1999), it is not necessary to distinguish between the median artery (arteria mediana), a developmentally aberrant vessel (a remnant of previous arterial trunks, following the older theory postulated by Singer in 1933 and the accompanying artery of the median nerve (*arteria comitans nervi mediani*). The latter term can be applied to all cases of this vessel, regarding its length relative to the forearm or hand (*antebrachii/manus*). The MA can serve as a collateral to the hand in case of either natural or iatrogenic stenosis, or closure of either radial or ulnar arteries.

CONCLUSION

The incidence of the accessory brachial artery is reported to be between 0.13-1.5%, and the incidence of the median artery varies from 8 to 19%. Until now, such a coincidence has not been reported, probably due to the absence of any practical uses for such observations in the past. The arterial variant of the upper limb has a high clinical relevance for catheterization through the radial or ulnar artery, for the harvesting of the radial artery as a graft or for the possible collateral circulation in cases of the arterial closure. The ABA can be hypoplastic or stenotic and can cause an unexpected complication during the surgical procedure.

Acknowledgments - Our sincere thanks to Vladimír Musil and Mirka Plecitá for technical and bibliographic support. The research was supported by Grand No. 262705/SVV/2011.

Table 1 – Authors reporting the accessory brachial artery

Author	Percentage frequency
Green 1830 (6)	mentioned
Quain 1844 (7)	0.23%
Tiedemann 1846 (8)	mentioned
Maestre 1864 (9)	mentioned
Henle 1876 (10)	mentioned
Ruge 1884 ("Inselbildung") (11)	mentioned
Herrington 1905 (12)	mentioned
Poynter 1920 (13)	mentioned
Hazlett 1949 (14)	0.53%
McCormack 1953 (15)	0.13%
Weathersby 1956 (16)	mentioned
Keen 1961 (17)	0.7%
Jurjus 1986 (18)	0.7%
Rodríguez-Niedenführ 2001 (27)	0.26%
Rodríguez-Niedenführ 2001* (19)	0.7%
Kachlik et al 2010	1.25%

* study performed on embryos

REFERENCES

Adachi, B (1928). *Das Arteriensystem der Japaner*. Maruzen, Kyoto, 285-356.

Bergman, R.A., Afifi A..K, and *R. Miyauchi* (1992-2004). Opus II: Cardiovascular System: Arteries: Upper Limb, In: *Illustrated Encyclopedia of Human Anatomic Variation*. Available on: http://www.anatomyatlases.org/AnatomicVariants/Cardiovascular/Text/Arteries/Median.shtml. Accessed 16 Dec 2010.

Burzotta, F., Trani, C., De Vita, M. and *F. Crea* (2009). A new operative classification of both anatomic vascular variants and physiopathologic conditions affecting transradial cardiovascular procedures, *Int. J. Cardiol.* **145**(1), 120-22.

De Garis, C.F., and *W.B. Swartley* (1928) The axillary artery in White and Negro stocks. *Am. J. Anat.* **41**, 353-397.

Evans, H.M. (1912). The Development of the vascular system. In: *Manual of human embryology* (Eds. F. Keibe and F.P. Mall), Vol. 2. J.B. 570-709. Lippincott, Philadelphia.

FCAT (1998). Terminologia anatomica. Thieme Verlag, Stuttgart.

Green P.H. (1830). *An Account of the Varieties in the Arterial System of the Human Body*.; James Marshal Leckie, Dublin, 16-20.

Hazlett, J.W. (1949). The superficial ulnar artery with reference to accidental intra-arterial injection. *Can. Med. Assoc. J.* **61** (3), 289-293.

Henle, J. (1868). *Handbuch der Systematischen Anatomie des Menschen*, vol. 3. Vieweg, Braunschweig, 267.

Henneberg, M. and *B.J. George* (1995). Possible secular trend in the incidence of an anatomical variant: median artery of the forearm. *Am. J. Phys. Anthropol.* **96** (4), 329-334.

Herrington, M. (1905). High bifurcation of the brachial artery with reunion at the elbows. *Johns Hopkins Hosp. Bull.* **16**, 65-66.

Jurjus, A., Sfeir, R. and *R. Bezirdjian* (1986). Unusual variation of the arterial pattern of the human upper limb. *Anat. Rec.* **215** (1), 82-83.

Kachlik, D., Baca, V., Bozdechova, I., Cech, P. and *V. Musil* (2008). Anatomical terminology and nomenclature: past, presence and highlights. *Surg. Radiol. Anat.* **30** (5), 459-466.

Kachlik, D., Konarik, M., Horak, D., Bernat, I. and *V. Baca* (2010). Anatomical difficulties of catheterization via arteria radialis. *Intervencni a akutni kardiologie*; **9** (2), 64-68 (article in Czech)

Kachlik, D., Konarik, M., Urban, M. and *V. Baca* (2011) Accessory brachial artery: a case report, embryological background and clinical relevance. *Asian Biomed*. – in press

Keen, J.A. (1961) A study of the arterial variations in the limbs with special reference to symmetry of vascular patterns. *Am. J. Anat.*, **108** (5), 245-261.

Konarik, M., Baca, V. and *D. Kachlik* (2010). Axillary artery: a compact survey based on 130 limbs. *Anatomy*, **4** (Suppl. 1), 29-30.

Konarik, M., Knize, J., Baca, V. and *D. Kachlik* (2009) Superficial brachioradial artery (the radial artery originating from the axillary artery): a case-report and its embryological background. *Folia Morphol. (Warszawa)*, **68** (3), 174-178.

Lippert, H. and *R. Pabst* (1985) *Arterial Variations in Man*. J. F. Bergmann, München, 71-73.

Maestre, A. (1864) *Notable anomalio de la arteria humeral*. La Espana Medica, Madrid.

McCormack, L.J., Cauldwell E.U. and *J. Anson* (1953). Brachial and antebrachial arterial patterns. *Surg. Gynecol. Obstet.* **96** (1), 43-45.

Poynter, C.W.M. (1922) *Congenital Anomalies of the Arteries and Veins of the Human body with Bibliography,* (Vol. 22). The University Studies of the University of Nebraska, Lincoln, 1-106.

Quain, R. (1844). *Anatomy of the Arteries of the Human Body*. Taylor and Wolton, London, 326-337.

Rodríguez-Niedenführ, M., Burton, G.J., Deu, J. and *J.R. Sañudo* (2001). Development of the arterial pattern in the upper limb of staged human embryos: normal development and anatomic variations. *J. Anat.* **199** (4), 407-417.

Rodríguez-Niedenführ, M., Sañudo, J.R., Vázquez, T., Nearn, L., Logan, B. and I. Parkin (1999). Median artery revisited. *J. Anat.* **195** (1), 57-63.

Rodríguez-Niedenführ, M., Vázquez, T., Nearn, L., Ferreira, B., Parkin, I. and *J.R. Sañudo* (2001). Variations of the arterial pattern in the upper limb revisited: a morphological and statistical study, with a review of the literature. *J. Anat.* **199**, 547-566.

Ruge, G. (1884). Beiträge zur Gefässlehre des Menschen. *Gegenbaurs Morphologisches Jahrbuch*, **9**, 329-388.

Singer, E. (1933). Embryological pattern persisting in arteries of the arm. *Anat. Rec.* **55**, 403-409.

Tiedemann, F. (1831) *Plates of arteries of human body*. McLachlan and Stewart, Edinburgh.

Trotter, M.I., Henderson, J.L., Gass, H., Brua, R.S., Weisman, S. and *H. Agress* (1930) The origin of branches of the axillary arteries in white and American Negros. *Anat. Rec*. **46**: 133-137.

Valsecchi, O., Vassileva, A., Musumeci, G., Rossini, R., Tespili, M., Guagliumi, G., Mihalcsik, L., Gavazzi, A. and *P. Ferrazzi* (2006) Failure of transradial approach during coronary interventions: anatomical considerations. *Catheter. Cardiovasc. Interv.* **67** (6), 870-878.

Weathersby, H.T. (1956) Anomalies of brachial and antebrachial arteries of surgical significance. *South. Med. J.* **49** (1), 46-49.