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Authors: Wojciech Przybycień, Michał Bonczar, Patryk Ostrowski, Kamil Możdżeń, Agnieszka Murawska, Anna Gil, Krzysztof Balawender, Jerzy Walocha, Mateusz Koziej

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Wojciech Przybycień[1], Michał Bonczar[1, 2], Patryk Ostrowski[1, 2], Kamil Możdżeń[1], Agnieszka Murawska[1], Anna Gil[1], Krzysztof Balawender[3], Jerzy Walocha[1, 2], Mateusz Koziej[1, 2]

[1]Department of Anatomy, Jagiellonian University Medical College, Krakow, Poland

[2]Youthoria, Youth Research Organization, Krakow, Poland

[3]Department of Normal and Clinical Anatomy, Institute of Medical Sciences, Medical College of Rzeszow University, Rzeszow, Poland

Address for correspondence: Dr. Mateusz Koziej, Department of Anatomy, Jagiellonian University Medical College, ul. Mikołaja Kopernika 12, 33–332 Kraków, Poland, e-mail: mateusz.koziej@gmail.com

ABSTRACT

The aim of the following study was to present and comprehensively describe a case of a bilateral absence of the DBA. Furthermore, its embryology and clinical significance will also be discussed.

During routine dissection, a 71-year-old male cadaver with a bilateral abnormality in the DBA and its branches was found. The first branch of the BA was found to be the radial collateral artery, which passed behind the radial nerve. Furthermore, the middle collateral artery originated distal to the radial collateral artery and gave off first a singular, minor muscular branch and then the superior ulnar collateral artery. Later, the preceding nutrient arteries of the humerus and the deltoid branch consecutively branched off from the middle collateral artery. Subsequently, the middle ulnar collateral artery, the inferior ulnar collateral artery, the deltoid artery, the radial artery, and the ulnar artery branched off from the BA, as

adapted in the current knowledge regarding the anatomy of the upper extremity. Furthermore, detailed measurements of the distances between the mentioned arteries were carried out.

In the present study, a bilateral absence of the DBA was demonstrated. Meta-analysis focusing on the anatomy of this artery has shown how variable its characteristics are. However, our case report is the first in the literature to present this extremely rare variation. Having adequate knowledge regarding the anatomy of the arteries of the proximal arm is of immense importance when performing orthopedic and reconstructive surgeries in this area.

Key words: deep brachial artery, arm, upper limb, anatomy, embryology

INTRODUCTION

The DBA, according to the literature, is considered the largest branch of the brachial artery in the arm. The DBA arises in the upper part of the arm on the posteromedial side of the BA and then runs in a downward direction, spiraling around the posterior surface of the humerus. During its course, the DBA accompanies the radial nerve and runs parallel to it along the radial groove. It assists in supplying the deltoid, triceps brachii, and anconeus muscles. The DBA divides into two branches as it reaches either the lateral interosseous septum or anterior to this septum. One of these branches is the radial collateral artery which, together with the radial nerve, passes through the lateral intermuscular septum and terminates by anastomosing with the radial recurrent artery. The second branch arising from the DBA is the middle collateral artery which anastomoses with the recurrent interosseous artery [11, 12, 14]. The DBA is involved in periarticular arterial anastomosis, which is located around the elbow joint.

As previously mentioned, the DBA is a branch of the BA, which is a continuation of the AA. During embryological development, the developing limb buds are supplied by the intersegmental arteries. The primary axial artery develops from the lateral branch of the seventh intersegmental artery and becomes the BA, which the DBA originates from [1].

Numerous anatomical variations of the DBA have been presented in the literature. As early as 1931, Charles et al. [2] created a classification based on the origin of the DBA. It consisted of origins such as a common origin with the superior ulnar collateral artery or the

subscapular artery, amongst others. Furthermore, reports of double and triple DBAs and the complete absence of this artery have also been reported [2–5, 13, 17].

Variations of the arterial system are frequently observed by medical professionals of many distinct specialties worldwide and oftentimes influence the daily clinical practice in the form of treatment options [18]. Having appropriate knowledge concerning the variable anatomy of the DBA is of immense importance when performing procedures such as the lateral forearm flap, cerclage wiring of the humeral diaphysis, and open subpectoral biceps tenodesis, amongst others [12, 14, 15]. Therefore, the aim of the following study was to present and comprehensively describe a case of a bilateral absence of the DBA. Furthermore, its embryology and clinical significance will also be discussed.

CASE REPORT

During routine dissection, a 71-year-old male cadaver with a bilateral abnormality in the DBA and its branches was found. Despite the currently adapted normal anatomy of the DBA [12, 14], the said vessel was absent.

On the left upper extremity

The first branch of the BA was found to be the radial collateral artery, which passed behind the radial nerve. Furthermore, the middle collateral artery originated distal to the radial collateral artery and gave off first a singular, minor muscular branch and then the superior ulnar collateral artery. Later, the preceding nutrient arteries of the humerus and the deltoid branch consecutively branched off from the middle collateral artery. Subsequently, the middle ulnar collateral artery, the inferior ulnar collateral artery, the deltoid artery, the radial artery, and the ulnar artery branched off from the BA, as adapted in the current knowledge regarding the anatomy of the upper extremity. Furthermore, detailed measurements of the distances between the mentioned arteries were carried out. All measurements were taken three times by three independent researchers (WP, PO, and MB), and a mean value was established, taking all measurements into account.

The distance between the origin of the radial collateral artery and the origin of the middle collateral artery was found to be 9.22 mm. The said distance was measured over the surface of the BA.

The distance, measured over the surface of the radial collateral artery, between the origin of the said artery and the origin of the first minor muscular artery was found to be 10.28 mm.

The distance, measured over the surface of the middle collateral artery, between the origin of the said artery and the origin of the minor muscular branch was found to be 8.10 mm.

The distance, measured over the surface of the middle collateral artery, between the origin of the minor muscular branch to the origin of the superior ulnar collateral artery was found to be 5.38 mm.

The distance between the origin of the middle collateral artery and the origin of the middle ulnar collateral artery, measured over the surface of the BA, was found to be 15.36 mm.

On the right upper extremity

The branching pattern the aforementioned branches was the same as in the left upper limb.

The distance between the origin of the radial collateral artery and the origin of the middle collateral artery was found to be 16.76 mm. The said distance was measured over the surface of the BA.

The distance, measured over the surface of the radial collateral artery, between the origin of the said artery and the origin of the first minor muscular artery was found to be 11.11 mm.

The distance, measured over the surface of the middle collateral artery, between the origin of the said artery and the origin of the minor muscular branch was found to be 14.91 mm.

The distance, measured over the surface of the middle collateral artery, between the origin of the minor muscular branch to the origin of the superior ulnar collateral artery was found to be 13.51 mm.

The distance between the origin of the middle collateral artery and the origin of the middle ulnar collateral artery, measured over the surface of the BA, was found to be 32.64 mm.

The mentioned abnormalities are presented in Figure 1 and 2.

DISCUSSION

Multiple studies have discussed the origin of the DBA. However, in a meta-analysis conducted by Przybycien et al., it was stated that the said artery originated most frequently (92.87%) directly from the AA or from the BA [12]. Variations included in this cohort were also cases of multiple DBAs (double, triple, etc.). The pooled prevalence of DBAs originating indirectly from the AA or BA was found to be 7.13%, where common origins with the subscapular artery, the superior ulnar collateral artery, and the posterior circumflex humeral artery were included. However, a total absence of the DBA is one of the rarest variations of the said vessel, especially a bilateral absence, such as the one demonstrated in the present case report. As mentioned earlier, Charles et al. presented a classification system of the various origins of the DBA consisting of seven types. Type I is the DBA branching out of the BA as a single branch, Type Ia is the DBA branching out as a double branch, and Type Ib is a triple branch. The DBA may also share a common origin with the superior ulnar collateral artery (Type II). The DBA originating at the teres major muscle between axillary and brachial arteries has been classified as Type III. Type IV means the DBA branching of the AA. The DBA may also branch off as a common trunk with the posterior circumflex humeral artery (Type V). The DBA can originate off the subscapular artery from the axillary artery (Type VI). The last variation described is Type VII with the complete absence of the DBA. This rare variation was also described by Ciervo in 2001 [3]. The DBA was absent and replaced by an unnamed tortuous branch running between the coracobrachialis and the triceps brachii muscle and then rejoining to the classic BA, next divided into the ulnar and radial. In this case, the ulnar collateral artery was also absent [3, 17]. The present case report demonstrates the variation type VII (the DBA is absent). However, to the best knowledge of the authors, the

present study is the first to present a case of a bilateral absence of the DBA in the available literature.

The embryology of the arterial system is incredibly complex, however, understanding it is essential in order to explain the variant anatomy of the upper limb. During the the 12th stage of the embryological period, blood vessels course into the developing limb bud. The capillary plexus infiltrates the limb primordium forming the axial artery and marginal veins. The saids vessel are responsible for the blood supply of the developing limb and terminal plexus of the future hand. Subsequently, the brachial, axillary, and anterior interosseous arteries develop from the axial artery [12, 14, 15]. The axillary and brachial arteries develop during the 16th and 17th stage of the embryological development [16]. Hence, the variations of the arterial network of the upper limb demonstrated in the present case study, occurred in that period.

Due to the absence of the DBA in the subject described in our study, the radial collateral artery and the middle collateral artery had an abnormal anatomy. The said arteries, both on the left and right upper limb, originated directly off the BA. Furthermore, the superior ulnar artery originated from the middle collateral arteries, rather than from its usual origin, which is the BA. This variability of the arterial anatomy of the upper limbs might pose problems when performing numerous surgical procedures in that area. The lateral forearm flap has increased in popularity and is commonly used for covering minor-to-moderate-sized defects for which thin and soft skin is needed [10]. The main artery supplying this reconstructive flap is the radial collateral artery, which is one of the terminating branches of the DBA. The present variation demonstrated in our study can pose problems for surgeons performing this flap, especially if they attempt to locate the radial collateral artery from its origin, which should normally be from the DBA. Furthermore, the close proximity of the radial collateral artery to the radial nerve, as presented in our case report, may put the radial nerve at risk of injury.

The DBA is also important to take into consideration concerning vascular injuries of the BA. The BA has been stated to be the most commonly injured artery of the upper limb, accounting for 28% of all vascular injuries [1, 6]. When evaluating a vascular injury to the BA, it is crucial to analyze whether the injury is proximal or distal to the DBA as this correlates with ischemia [9]. It is said that if the BA is damaged distal to the origin of the DBA at the inferior border of the teres major muscle, the DBA will act as the primary source

of collateral circulation to the distal extremity. Despite the variable arterial anatomy of the proximal upper limbs presented in the current case report, the branches of the DBA still had a relatively proximal origin, approximately at the same level of which a normal DBA would have (being the first branch of the brachial artery).

The cerclage wire technique is generally used as a fixation mechanism for a fracture, to stabilize fractures around the prosthetic stem in the presence of osteoporosis, to prevent intraopreative propagation of a fracture, and as an indirect reduction tool, amongst others [7]. When inserting cerclage wires into the proximal arm, great care must be taken due to the risk of damaging the DBA and the accompanying radial nerve [12]. In our case report, the DBA was absent bilaterally, and its terminating branches (radial and middle collateral arteries), originated directly off the BA at the same level at which a usual DBA would have. The radial collateral artery, in both upper limbs, coursed beneath the radial nerve, constantly being in a very close proximity to it. Therefore, even though the DBA is absent in our subject, the risk of damaging its terminating arteries would still be as high when performing the cerclage wire technique in the proximal part of the upper limb.

CONCLUSIONS

In the present study, a bilateral absence of the DBA was demonstrated. Meta-analysis focusing on the anatomy of this artery has shown how variable its characteristics are [12]. However, our case report is the first in the literature to present this extremely rare variation. Having adequate knowledge regarding the anatomy of the arteries of the proximal arm is of immense importance when performing orthopedic and reconstructive surgeries in this area.

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Figure 1. Left upper limb of the said cadaver.

Figure 2. Right upper limb of the said cadaver.