Rare origin of the brachioradial artery - A case found on a historical specimen prepared by Ludwik Karol Teichmann

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ABSTRACT

Historical sources can serve as an important point of reference for anatomical research. In this report, we present an atypical origin of the brachioradial artery from the distal fourth of the arm. The radial recurrent artery originated from the ulno-interosseous trunk and crossed the brachioradial artery posteriorly at the level of the neck of the radius. This case reported herein was observed during a review of the historical specimens collection prepared in the 19th century by the prominent Polish anatomist Ludwik Karol Teichmann and his collaborators and exhibited in the Anatomy Museum of Jagiellonian University Medical College. The goal of this study was to provide data on the course and branching pattern of a rare variant of the brachioradial artery.

1. Introduction

As one of the two terminal branches of the brachial artery, the radial artery is one of the main arteries of the forearm and hand [1]. Typically, it arises in the cubital fossa – distal to the inter-epicondylar line of the humerus, at the level of the neck of the radius [2,3]. Numerous variations regarding the origin and branching patterns of the radial artery have been reported [3-12]. For instance, the artery may occasionally arise proximal to the inter-epicondylar line of the humerus, from the brachial artery or the axillary artery [4-11]. Such an atypical origin is referred to as a “high origin of the radial artery” [5] or “high bifurcation of the brachial artery” [4]. Based on the most recent terminology, however, the radial artery of high origin is referred to as the brachioradial artery [5,9-11]. The incidence of this variant ranges from 4.67% to 15.6% [5]. Among such cases, the proximal half of the humerus is the most common origin [5,7,10,11]. McCormack et al. [7], in a study of 750 extremities, reported a radial artery of high origin arising in the distal fourth of the arm in only four cases.

In this report, we present a case with an atypical origin of the brachioradial artery in the distal fourth of the arm. This case was observed during a review of the historical specimens collection prepared in 19th century by the prominent Polish anatomist Ludwik Karol Teichmann [12] and his collaborators and exhibited in the Anatomy Museum of Jagiellonian University Medical College. The goal of this study was to provide data on of the course and branching pattern of a rare variant of brachioradial artery.

2. Case description

An atypical origin of the brachioradial artery was found in the right upper limb of an anatomical specimen in the Anatomy Museum (originally Theatrum Anatomicum) of Jagiellonian University Medical College (Fig. 1).

The brachial artery was found to divide into the radial and ulnar arteries (or precisely, it was divided into the brachialradial artery and ulno-interosseous trunk) 48 mm proximal to the inter-epicondylar line of the humerus, with an arm length of 290 mm; Thus, the origin of the brachioradial artery was located in the distal 16% of the arm’s length...
At the level of the brachial artery division, the inferior collateral ulnar artery originated. The initial part of the brachioradial artery crossed the distal biceps brachii tendon anteriorly and then moved downward to run on the lateral side of the forearm. At the wrist, the artery coursed to the posterior surface of the hand, pierced the first intermetacarpal space and ended as a well-developed deep palmar arch.

The radial recurrent artery originated from the ulno-interosseous trunk, 17 mm distal to the inter-epicondylar line of the humerus. The radial recurrent artery crossed the brachioradial artery posteriorly at the level of the neck of the radius. The common interosseous artery arose 56 mm distal to the inter-epicondylar line of the humerus. The ulnar artery occupied an ordinary position. In the hand, it gave rise to the deep branch that anastomosed distally with the deep palmar arch and terminated as the superficial palmar arch (partially damaged on the specimen).

The diameters of the radial and ulnar arteries were measured at the level of the wrist for comparison of each’s contribution in hand blood supply. The measurements of the external diameter of these arterial trunks were taken with a Digimatic Caliper (Mitutoyo Corporation, Kawasaki-shi, Kanagawa, Japan). The diameters of the ulnar and brachioradial arteries at the level of the wrist were 2.99 mm and 3.22 mm, respectively.

3. Discussion

Systematic research into the anatomical variations of the arteries of the upper limb flourished in the 19th century. Pioneering research in this area was carried out by Friedrich Tiedemann who was a German anatomist and physiologist. In *Friderici Tiedemann Tabulæ arteriarum corporis humani* [13], a few figures illustrate an abnormally proximal origin of the radial artery (Fig. 2). Arterial variations of the upper limb were also presented by Richard Quain in his richly illustrated work entitled *The anatomy of the arteries of the human body and its applications to pathology and operative surgery with a series of lithographic drawings* [8].

Based on this work, a radial artery with a high origin arose from the axillary artery in 30% and in 70%, in the arm (in the upper third in 39.5% of cases, in the middle third in 24.6% of cases and in the lower third in 9.5% of cases) [8,10]. Similar results were provided by Adachi who noted an axillary artery origin of the radial artery in 31% and brachial artery origin in 69% of cases, in which the high division of the brachial artery was observed [14]. In one of the most recent reports released, the axillary artery origin of the brachioradial artery was found in two out of 120 dissected upper limbs (which was 1.67% of all specimens and 18.1% of brachioradial arteries) [5]. In the same study, nine cases (7.5% of all limbs; 81.8% of brachioradial arteries) involved a brachial artery origin of the brachioradial artery [5]. In one of the most recent reports released, the axillary artery origin of the brachioradial artery was found in two out of 120 dissected upper limbs (which was 1.67% of all specimens and 18.1% of brachioradial arteries) [5]. In the extensive study of McCormack et al., the prevalence of the various levels of the radial artery origin was assessed. Out of 750 examined limbs, 16 specimens (2.13%) showed an axillary artery origin of the radial artery, 51 limbs (6.8%) exhibited radial artery origin in the proximal fourth of the arm, in 31 limbs (4.13%) the radial artery arose in the next quarter of the arm.
forearm, in five cases (0.67%) the radial artery arose in the penultimate quarter of the forearm, and in the four cases (0.54%), the radial artery arose in the most distal fourth of the forearm. The latter case corresponds to the variant described herein. According to Nasr et al. [3], the mean distance of the bifurcation of the brachial artery into terminal branches was 38.7 ± 9.5 mm in men and 36.5 ± 8.5 mm in women; These authors referred to this level as a “normal origin” of the radial artery. In the study of Haładaj et al. [5], the brachial artery arose from 126 mm to 260 mm proximal to the inter-epicondylar line of the humerus (mean 178 mm, ± 44 mm) and no variant arose in the distal half of the arm. However, in rare cases, a low origin of the radial artery may develop. In such cases, the radial artery may arise more distally, deep to the pronator teres muscle [13].

Early developmental relations can explain the occurrence of radial artery origin at different levels. Newer models of the upper limb arteries’ formation assume that the definitive arterial pattern results from the separation of the main arterial trunks within the primitive capillary plexus [9–11]. According to this model, the dominant vascular channels differentiate during capillary remodeling [9].

Anatomical arterial variations of the upper limb can often be correlated with the variations of the radial recurrent arteries [5,16]. According to Vazquez et al. [16], the radial recurrent artery most often takes its origin from the radial artery (64.8%); It may also branch from the posterior radio-ulnar division (9%), anterior radio-ulnar division (5.4%), brachioradial artery (7.8%), brachial artery (7.2%), ulno-interosseous trunk (2.7%) - as in our case, or the interosseous trunk (0.3%). It is worth emphasizing that in our case, the radial recurrent artery showed a characteristic topography, running backwards from the proximal part of the brachioradial artery. Since flaps involving the radial recurrent artery are used in plastic and reconstructive surgery, atypical variants of the course of this vessel may be of clinical significance [16].

4. Applied anatomy

As stressed by Vergara-Garcia et al. [17], p. 5, the brachioradial artery is one of the most frequently encountered anatomical variations of the upper limb, and “The presence of such may alter the success rate of neurovascular diagnostic procedures and therapeutic strategies.” Anatomical variations of the radial and brachioradial arteries might influence radial artery cannulation, surgical procedures, as well as trauma repair [18–22]. For instance, catheterization of the radial artery (so-called transradial access) may be altered by the vessel’s abnormal origin and course. Some reports indicate that the presence of a high origin of the radial artery (brachioradial artery) may be associated with a more tortuous course of this vessel, which might increase the risk of catheterization failure [18]. Thus, awareness of radial artery anatomical variations helps overcome difficult anatomy during the transradial approach [20]. Regarding the brachioradial artery, Vergara-Garcia et al. [(17), p. 5] concluded that “It is crucial to get familiarized with such vascularization to avoid a problematic or unsuccessful access.” McCormack [7] also emphasized hazards resulting from an atypical course and topography of upper limb arteries. In such cases, a major artery may occur in an atypical location, where it is not expected. It is particularly true regarding the antebrachial region. In this context, the risk of accidental intra-arterial injections should be considered, especially when an aberrant artery occurs. An iatrogenic intra-arterial injection may cause forearm and hand ischaemia [7]. Also, the radial artery is often used in vascular, plastic, and reconstructive surgery. An atypical course of that artery may influence various surgical approaches, arterial grafting, or anterior forearm surgical exposure [7,19,21,22].

5. Limitation of the study

Not all arterial branches could be traced since it was not possible to reach the deeper muscle layers without damaging the specimen. The nerves were removed during the preparation of the specimen (probably to better visualize arterial pattern). Therefore, the topographical relations between the brachial artery and median nerve as well as the relations between the brachioradial artery and the superficial branch of the radial nerve could not be examined. Since the dissection was conducted on a single isolated upper limb, we could not perform a whole-body study of anatomical variations. Kahn et al. [23] suggest that, if possible, a whole-body analysis of arterial variants in a single anatomical donor should be considered. However, specimens from such historical collections may still serve as an important point of reference for anatomical research [7,8,13,14].

6. Conclusions

As the radial artery is frequently used in vascular, plastics and reconstructive surgery, knowledge of its variations may be of clinical importance. Therefore, accurate descriptions of anatomical variations such as the brachioradial artery can be useful.

Ethical statement

N/a.

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Declaration of competing interest

None declared.

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