

Research Article

High origin of radial artery: a comparative, anatomical and embryological consideration

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Received: 05 June 2016

Revised: 12 June 2016

Accepted: 06 July 2016

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ABSTRACT

Background: Radial artery is one of the terminal branches of the brachial artery arising in the cubital fossa about 1 cm below the bend of the elbow. Diversions of the radial artery from its normal anatomical pattern as regards to its origin or its course constitute the largest group of vascular variations of the upper extremity. Unusual origin of the radial artery may cause failure of transradial approach for percutaneous coronary angiography and difficulty in the reconstructive surgery of the upper limb.

Methods: The present study was conducted in the Department of Anatomy at LLRM Medical College on 16 formalin fixed cadavers (12 male and 4 female) of adult age group i.e. 32 upper limbs. Axilla and arm was carefully dissected. Axillary artery and brachial artery were dissected and its branching pattern was observed to note the origin of radial artery. The course of radial artery was noted in each case.

Results: Radial artery took origin from the third part of the axillary artery in 3.12%. It arose 2 cm above the lower border of teres major, coursed superficial to median nerve in the arm and continued in the forearm as such. The brachial artery after giving its branches continued as ulnar artery in the forearm. In 96.88%, radial artery arose normally in cubital fossa.

Conclusions: High origin and superficial course of the radial artery may be hazardous and vulnerable to injury during venepuncture and surgical procedures. This type of anomaly is due to failure of formation of the communicating branch between superficial brachial artery and axial artery at level of elbow. Awareness about details and topographic anatomy of such variations may help to prevent diagnostic errors, influence surgical tactics and interventional procedures.

Keywords: Radial artery, Seventh intersegmental artery, Superficial brachial artery, High origin

INTRODUCTION

Incidence of variation in the arterial pattern of the upper limb varies from 18.53% to 20%.^{1,2} Knowledge about the vascular structure of the upper extremity is important for diagnostic interventions and surgical approaches.³ Diversions of the radial artery from its normal anatomical pattern as regards to its origin or its course constitute the largest group of vascular variations of the upper

extremity.^{1,4,5} Radial artery is one of the terminal branches of the brachial artery arising in the cubital fossa; the other being the ulnar artery. Radial artery usually begins in the cubital fossa about 1 cm below the bend of the elbow at the level of the neck of the radius just medial to the tendon of biceps brachii muscle, and terminates in the hand by forming the deep palmar arch after anastomosing with the deep branch of the ulnar artery.⁶ Incidence of high origin of radial artery varies from

4.17% to 15.60% in cadavers and embryos.^{1,2,7} In angiographic images, the same incidence varies from 8.00% to 24.40%.^{4,8}

According to Hollinshead, as the aortic arches are resolved into their definitive condition, a part of the aortic arch system plus the seventh segmental artery becomes the subclavian-axillary stem on the right side and the seventh segmental artery alone becomes the subclavian-axillary stem on the left side.⁹ Variations in the vasculature of the upper extremity are due to defects in embryonic development of the vascular plexus of upper limb bud.

The present study was designed to establish the origin of radial artery in Western UP population and to analyze the data in the light of the accessible literature.

METHODS

The present study was conducted in the Department of Anatomy at LLRM Medical College, Meerut on 16 formalin fixed cadavers (12 male and 4 female) of adult age group i.e.32 upper limbs. Axilla and arm was carefully dissected. The origin and course of radial artery was noted in each case. Axillary artery and brachial artery were dissected and its branching pattern was observed to note the origin of radial artery. Formalin fixed cadaver with any sign of surgery or instrumentation of that area were not included.

RESULTS

Radial artery took origin from the third part of the axillary artery in 3.12%. In 96.88%, radial artery arose normally in the cubital fossa. In the variant case, the radial artery of the right upper extremity of a middle aged male cadaver arose 2 cm above the lower border of teres major. It coursed superficial and lateral to median nerve in the arm and continued in the forearm as such (Figure 1). In the cubital fossa, there was no communication between the radial artery and the ulnar artery and the radial artery traversed superficially in the forearm. In the forearm, the radial artery was seen passing superficial to all flexor muscles, running along the lateral side of forearm. In the hand it followed the usual course in contributing to formation of superficial palmar arch and continued as deep palmar arch. The brachial artery after giving its branches continued as ulnar artery in the forearm. On the left side, radial artery had normal origin and course

DISCUSSION

In the present study, high origin of radial artery was observed in 3.12% which correlated with McComark et al who studied 750 extremities of cadavers and found high origin of radial artery in 2.13% (16 of 750 arms) of cases, Yang et al who studied 304 Korean cadavers, observed this in 2.3% of cases and Konarik et al reported

this in 3% of cases.^{1,10,11} The findings of the present study regarding high origin of radial artery did not correlate with Rodriguez-Baeza et al (1995) who found the origin of radial artery from axillary artery in 10.66%.¹²(Table 1).

Table 1: Comparison of the incidence of high origin of radial artery with the previous studies.

Name of the author (year of the study)	% of cases
Dubreuil and Chamberdel (1906)	13.97%
McComarck et al (1953)	2.13%
Rodriguez-Baeza et al (1995)	10.66%
Rodriguez-Niedenfuhr et al (2001)	6.25%
Yang et al (2008)	2.3%
Konarik et al (2009)	3.0 %
Present study (2016)	3.12 %

Dubreuil and Chamberdel reported 72 cases of high origin of radial artery out of 136 cases and among these 19 were arising from the axillary artery.¹³ Rodriguez-Niedenfuhr et al reported 12 upper limbs showing the radial artery arising from the axillary artery among 192 upper limbs and named the radial artery arising in the arm as the superficial brachioradial artery.²

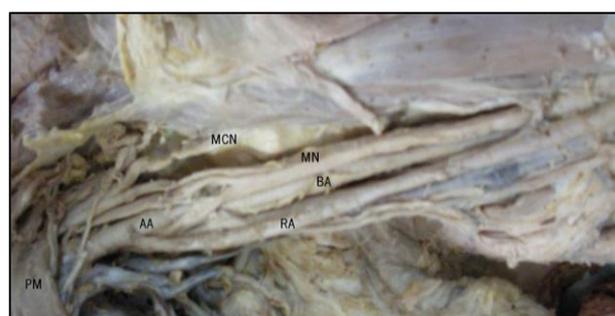


Figure 1: Origin of the radial artery (RA) from the third part of the axillary artery (AA) in the right axilla. (BA- brachial artery, MN-median nerve, PM-pectoralis minor, MCN- musculocutaneous nerve).

Compta, Icten et al, Okoro and Jiburum, Waghmare et al, Zhan et al, Balachandra et al, Vinila et al also reported the radial artery arising from the axillary artery. Loukas et al have reported a case of radial artery arising from the thoracoacromial trunk.⁴⁻¹⁹

According to Rodriguez-Baeza et al and Singer, this type of anomaly is due to failure of formation of the communicating branch between superficial brachial artery and axial artery at level of elbow and thus superficial brachial artery did not disappear but continued as radial artery (Figure 2).

The superficial course of radial artery in upper part of forearm can be explained on the basis of haemodynamic mechanism between deep and superficial arteries in the forearm. Normally due to deep haemodynamic

predominance, superficial terminal branches of radial artery undergo developmental arrest and deep part persists as normal radial artery. High origin of radial artery is due to variations in haemodynamic factors which lead to regression of deeper vessels and persistence of one of the superficial terminal branches of radial artery.^{12,21}

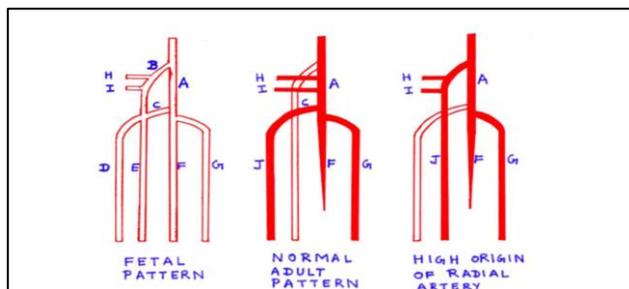


Figure 2: Schematic diagram showing embryological basis of high origin of radial artery.(a-axial artery, b-superficial branch of subclavian artery/SBA in fetal life, c-communication between SBA and brachial artery at elbow, d-deep branch of SBA in fetal life, e-superficial terminal branch of sba in fetal life, f-interosseus artery, g-ulnar artery, j-radial artery, h and i- muscular branches).

According to Hollinshead, the radial artery first arises from the brachial well above the elbow and only subsequently is the high origin replaced by a lower one. Persistence of the more proximal origin of the radial artery leaves this origin in the arm, from the axillary artery or the upper part of the brachial.⁹

According to Madhyastha et al and Waghmare et al, radial artery arising from the third part of the axillary artery has a superficial course in the arm as well as the forearm. Such unusual origin of the radial artery may cause difficulties in transradial approach for percutaneous coronary angiography and in the reconstructive surgery of the upper limb. These variations have to be kept in mind during orthopedic, vascular and reconstructive surgeries. Intravenous injections to a superficial artery can be disastrous as these arteries can be confused for veins.^{16,22}

The presence of these high origin variants of radial artery poses problems with radial forearm free flaps due to their proximity to intravenous infusion sites.²³ According to Diami et al, the high origin and superficial course of the radial artery may be hazardous and vulnerable to injury during venepuncture and surgical procedures. On the other hand, its superficial course makes arterial grafting and cardiac catheterization easier.²⁴

Arteriography should not be performed when there is difficulty in advancement of the guidewire or the catheter in transradial procedures.⁸ A variant radial artery may complicate angiographic procedures and lead to

misinterpretation of incomplete angiographic images.^{25,26} Compression of the median nerve by the variant radial artery could be misdiagnosed as radiculopathy and neuropathy.²⁶ It has also been reported to produce problems in cannulation for operation monitoring.²⁷ Superficial position of the radial artery makes it more vulnerable to trauma resulting in bleeding.⁵

CONCLUSION

Awareness about details and topographic anatomy of variations of the arteries of upper extremity region may help to prevent diagnostic errors, influence surgical tactics and interventional procedures and avoid complications during orthopedic, vascular and reconstructive surgery. The superficially located artery elevates the risk of heavy bleeding in unexpected situations, not only in medical care but also during common personal daily activities.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Agarwal S, Lalwani R, Babu CSR. High origin of radial artery: a comparative, anatomical and embryological consideration. *Int J Res Med Sci* 2016;4:3295-8.