Surgical significance of brachial arterial variants in a Kenyan population

Authors: **Pulei A** BSc (Anat), MBChB, **Obimbo M** MBChB, MSc (Anat), **Ongeti K** BSc (Anat), MBChB**, Kitunguu P** BSc (Anat), MBChB, **Inyimili M,** HND**, Ogeng'o J** BSc, MBChB, PhD. *Correspondence and reprints requests:* Dr. Anne Pulei, Department of Human anatomy, University of Nairobi PO Box 30197 00100 Nairobi. Email: anmunkush@yahoo.com

Abstract

Background: Knowledge of the variant anatomy of the brachial artery is important in radial arterial grafts for coronary bypass, percutaneous trans-radial approach to coronary angiography, angioplasty and flap surgery. These variations show ethnic differences but data from black populations are scarce. This study therefore describes the course in relation with median nerve, level and pattern of termination of brachial artery in a black Kenyan population.

Methods: This was a cadaveric dissection study of 162 upper limbs at the Department of Human Anatomy University of Nairobi, Kenya. The brachial artery was exposed entirely from the lower border of teres major to its point of termination. The course in relation to the median nerve and the level of termination were recorded. The results were analyzed using SPSS version 17.0 for Windows.

Results: 72.2% of the brachial arteries followed the classical pattern described in Gray's Anatomy. Superficial brachioradial and superficial brachial arteries were present in 12.3% and 6.1% of the cases respectively. Brachial artery terminated at the radial neck in 79% of the cases, radial tuberosity (8.6%), and proximal arm (11.1%), mid arm (1.2%). Pattern of termination was either a bifurcation into the radial and ulnar arteries (90.1%) or trifurcation into radial, ulnar and common interosseous arteries (9.3%). We also report a case of trifurcation of the brachial artery into the profunda brachii, radial and ulnar arteries (0.6%).

Conclusion: Variations of the brachial artery in its relationship with the median nerve, level and pattern of termination are common. These may complicate arm surgical exposures, flap and vascular surgery. Pre-operative angiographic evaluation is recommended.

Keywords: brachial artery, bifurcation, trifurcation, superficial brachioradial artery

Introduction

The brachial artery, a continuation of the axillary, usually begins at the lower border of teres major muscle courses deep to the median nerve and ends at the level of the neck of the radius by dividing into ulnar and radial arteries (1). Variations occur in course of the artery in relation to the median nerve (2, 3), pattern and level of bifurcation (4-6). Variant anatomy is important in trans-radial percutaneous coronary angiography or when using radial artery for coronary bypass grafts (7, 8). Complications as a result of the variant pattern of this artery have been reported in surgical procedures (9). Knowledge of these variations is important to avoid complications of accidental intra-arterial injection of medication into superficial arteries that may lead to clinically important sequelae such as to paraesthesias, severe pain, motor dysfunction, compartment syndrome, gangrene, and limb loss (10). This study reports surgically relevant variants of the brachial artery in a black Kenyan population.

Materials And Methods

This was a dissection study carried out on 162 upper limbs from 81 cadavers of adult black Kenyans in the Department of Human Anatomy, University of Nairobi. Vertical incisions were made on the lateral and medial borders of the arm from the coracoid process and axilla proximally to the mid forearm. These incisions were joined by transverse ones and the skin flaps removed. The biceps brachii was sectioned in the middle, the ends retracted and the fascia split to expose the brachial artery in its entire extent from the axilla to the cubital fossa. The artery was traced proximally to its continuity with the axillary artery at the lower border of teres major and distally to its point of termination. The course in relation to the median nerve, level and pattern of termination were identified as follows; normal (classical pattern), an artery with a classical origin, course and branching pattern as described in Gray's Anatomy (1). This artery originates from the lower border of Teres major muscle and coursed deep to the median nerve, terminating at the level of the radial tuberosity into the ulnar and radial arteries. Superficial brachial artery described an artery with a course superficial to the median nerve (3, 11, 12). Brachioradial artery described a proximal origin of the radial artery in the arm which courses superficial to the median nerve. Photographs of the representative pat-

terns were taken using a Sony cybershot ® camera 14.1 mega pixels, 4x optical zoom. The results were analysed using the Statistical Programme for Social Scientists (SPSS) version 17 for Windows and presented in tables and macrographs.

Results

Brachial artery was present bilaterally in all 162 upper limbs studied. Variations were observed in course, level and pattern of termination. The usual anatomical description of the brachial artery occurred in 72.2% (117 of the cases) of the cases. The artery was found to course superficial to the median nerve mainly as the brachioradial artery (12.3%) in which case the artery bifurcated in the arm, and the radial artery coursed superficial to the nerve. A superficial brachial artery existed in 6.1% of the cases.

Regarding the point of termination of the brachial artery, 79% terminated at the radial neck (Fig. 1A). Twenty brachial arteries (12.3%) had a proximal bifurcation in which case the radial artery coursed distally at first medial to the median nerve then arching superficial to the median nerve from medial to lateral (Fig.1B). These proximal bifurcations occurred either in the proximal third of the arm, 18 cases, 11.1%, (Fig. 1B) or mid arm level 2 cases, 1.2% (Fig 1C). Fourteen brachial (8.6%) arteries took a longer course and terminated at the level of the radial tuberosity (Fig.1D). The mode of termination observed in this study was either a bifurcation of the brachial artery into ulnar and radial arteries 146 (90.1%) or a trifurcation into the ulnar, radial and common interosseous arteries 9.3% (Fig. 1D, E). In one case (0.6%), the brachial artery terminated in the arm as a trifurcation into the radial, ulnar and profunda brachii arteries (Fig. 1F).

Table 1: Incidence of superficial brachial artery

Number	Name of author	Percentage	Population
1.	Adachi, 1928 (11)	0.1	Japanese
2.	Keen, 1961 (2)	3.6	British
3.	Yang et al. 2003 (15)	12.2	Korean
4.	Kachlik et al. 2011 (16)	5	Czech
5.	Present study	6.1	Kenyan

Table 2: Incidence of proximal origin of the radial artery

Number	Name of author	Percentage	Population
1.	De Garis and Swartley,		
	1928 (18)	7.7	American
2.	Miller, 1939 (13)	3.0	American
3.	Keen, 1961 (2)	5.9	British
4.	Anson, 1966 (17)	15	American
5.	Rodriguez-Niedenfuhr,		
	2003 (12)	14	Spanish
6.	Present study	12.3	Kenyan

Discussion

In the present study, 72.2% of the limbs displayed the classical pattern of the brachial artery. This is lower than the 82% reported (6) in an Indian population. The existence of such variations of the upper extremity is clinically important. They may complicate intravenous drug administration as well as percutaneous brachial catheterization. For instance, in the present study, 10 (6.1%) brachial arteries coursed superficial to the median nerve, higher than 3.6% reported by Keen (1961) [Table 1] (2). Miller (1939) suggested the superficial brachial artery was an atavistic feature as he considered a brachial artery passing anterior to the median nerve to be the usual arrangement in primates (13). Such an artery may be mistaken for a vein. Its superficial course makes it more prone to injury, which may result in profuse bleeding. On the other hand, the superficial brachial artery could be used as a feeding artery to a free flap from medial arm skin (14). The brachial artery terminated proximal to the intercondylar line in 12.3% of the cases, in all cases, the radial artery being superficial to the median nerve. Our findings therefore indicate a proximal origin of the radial artery in 12.3 % of the cases. This is almost similar to the findings of Anson (1966) and Rodriguez-Niedenfuhr (2003) in American and Spanish populations respectively (12, 17). Previous studies (2, 13, 18) have documented varying incidences of the proximal radial artery (Table 2).

The proximal radial artery is the commonest variation of the termination of the brachial artery (4, 19). Knowledge of such variations is of clinical significance. For example, iatrogenic pseudo aneurysm of the radial artery in the arm may follow chronic hemodialysis (20). Anatomical variations of the radial artery have also been implicated in failures of the transradial approach for percutaneous coronary procedures (21).

Trifurcation into radial, ulnar and common interosseous arteries occurred in 9.3% of the cases. Trifurcation of the brachial artery has been previously observed, into; ulnar, radial, common interosseus or median artery (22), ulnar, radial and radial recurrent arteries

Surgical significance of brachial arterial variants in a Kenyan population

Pulei A, Obimbo, Ongeti K, Kitunguu P, Inyimili M, Ogeng'o J

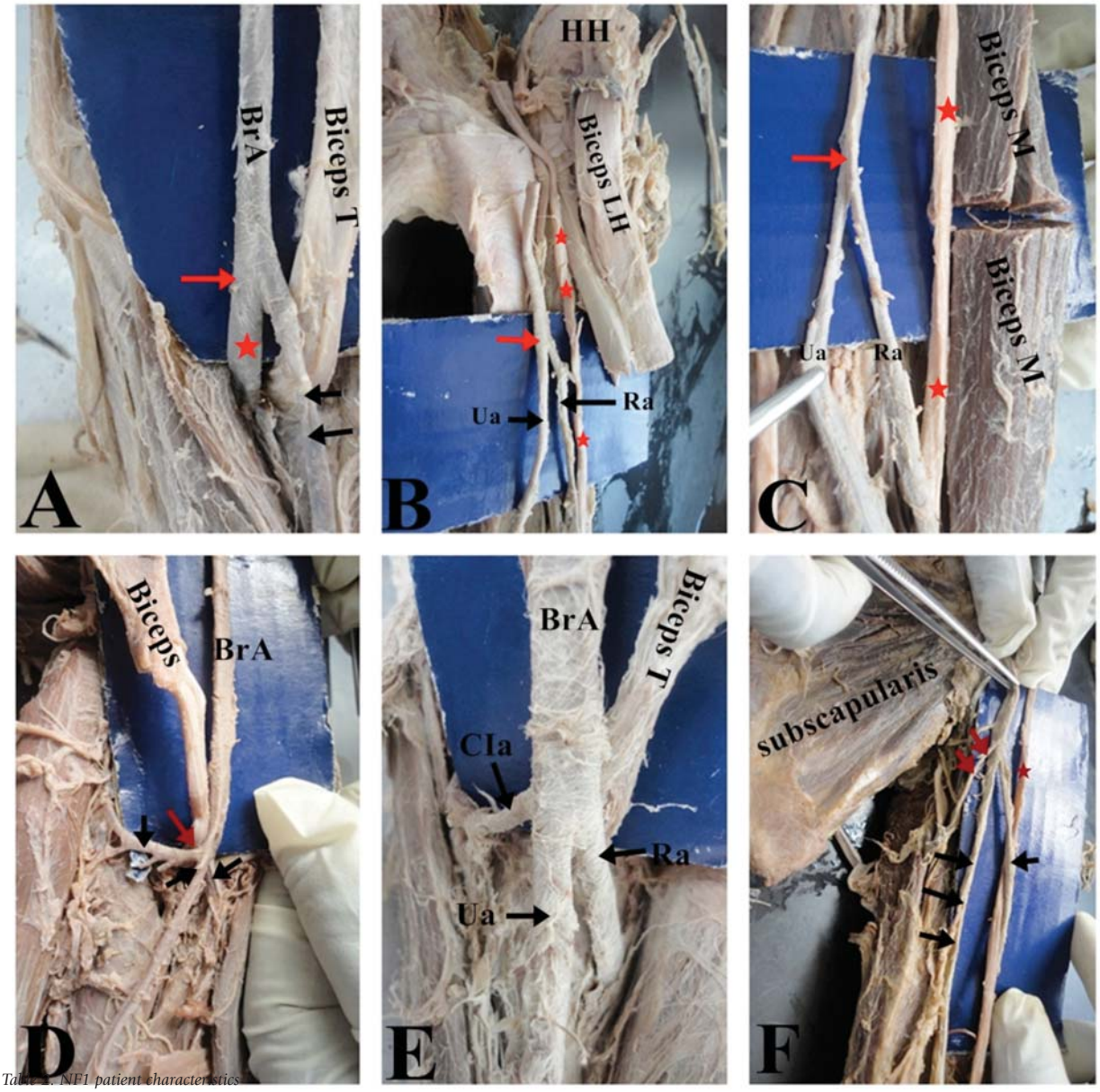

Table 2. NF1 patient characteristics

Legends

Fig. 1: A-F: Mode and point of termination of the brachial artery. A: usual pattern and point of termination (red arrow) of the brachial artery (BrA), at the level of the radial neck into ulnar (black arrow) and radial arteries (red star). B: Proximal third arm bifurcation of the BrA (single red circle), HH is the head of the humerus while Biceps LH is the long head of biceps. Ra is the radial artery, Ua is the ulnar artery. The red star is on the radial nerve. C: Mid arm bifurcation of the brachial artery (Red arrow), into the ulnar (Ua) and radial (Ra) arteries. Note that the radial artery courses superficial to the radial nerve (red star). The biceps muscle is transected at its mid-point. D: Low trifurcation of the BrA, at the level of the radial tuberosity where the biceps tendon inserts as shown by the red arrow. Note that it trifurcates into the ulnar, radial and common interosseous arteries as shown by the black arrows. E: Trifurcation of the brachial artery (BrA), into the common interosseous (CIa), radial (Ra) and ulnar arteries (Ua). F: Trifurcation of the brachial artery in the proximal arm into the profunda brachii artery (two red arrows), ulnar artery (three black stars), and radial artery (single black arrow). Note that the radial artery courses superficial to the radial nerve (red stars).

(6) and ulnar, radial and common interosseous arteries (23). Other unique forms of trifurcations include divisions into the radial, ulnar and superior ulnar collateral arteries (24) and radial, ulnar and radial recurrent arteries (6). We report an inimitable trifurcation of the brachial artery into the profunda brachii, ulnar and radial arteries and a low termination of the brachial artery. Our consult of literature reveals only a single case report of this variant (25). Low termination of the brachial artery may lead to inadvertent vascular complications in forearm surgeries.

Variations of the brachial artery in its relationship with the median nerve, level and pattern of termination are not uncommon. These may complicate arm surgical exposures, interventional radiology, flap and vascular surgery. Pre-operative angiographic evaluation is recommended.

Acknowledgement

We are thankful to the staff of Gross Anatomy Laboratory namely Mr. Jacob Gimongo, Charles Githinji and Peter Nziu for their technical support. We thank Dr. Beda Otieno and Dr. Duncan Anangwe for their assistance in data collection. We are grateful to Dr. Pamela Mandela for her assistance in photograph management.

Conflict of interest: None
Source of funding: None

References

1. Standring S, Johnson D, Ellis H, et al. Gray' s Anatomy, 39th edition. Churchill Livingstone, London 2005; 356.
2. Keen JA. A study of arterial variations in the limbs with special reference to symmetry of vascular pattern. Am J Anat 1961; 108:245-261.
3. Melling M, Wilde J, Schnallinger M, et al. Rare variant of the brachial artery; superficial lateral inferior type IV EAB. Clin Anat 2000;13:216-222.
4. Karlsson S, Niechajev IA. Arterial anatomy of the upper extremity. Acta Radiol 1982; 23:115-121.
5. Celik HH, Sargon MF, Konan A, et al. High brachial artery bifurcation. A case report of 2 cases. Bull Assoc Anat (Nancy) 1996; 80: 13-14.
6. Patnaik VVG, Kalsey G, Singla RK. Branching pattern of brachial artery- A morphological study. J Anat Soc India 2002; 51:176-186.
7. Molinari G, Nicoletti I, De Benedictis M, et al. Safety and efficacy of the percutaneous radial artery approach for coronary angiography and angioplasty in the elderly. J Invasive Cardiol 2005; 17:651-4.
8. Shipulin VM, Kozlov BN, Korovin NV, et al. Intraoperative preparation of the radial artery for coronary artery bypasses grafting. Angiol Sosud Khir 2005; 11:122-6.
9. Heden P, Gylbert L .Anomaly of the brachial artery encountered during elevation of the radial forearm flap. J Reconstr Microsurg 1999; 6:139-141.
10. Sen S, Chini EN, Brown MJ. Complications after unintentional intra-arterial injection of drugs: Risks, outcomes and management strategies. Mayo Clin Proc 2005:80(6); 783-795.
11. Adachi B. Das Arteriensystem des Japaner, Kyoto 1928; 1:205-10.
12. Rodriguez-Niedenfuhr M, Vazquez T, Parkin IG, et al. Arterial patterns of the human upper limb: update of anatomical variations and embryological development. Eur J Anat 2003; 7:21-28.
13. Miller RA. Observations upon the arrangement of the axillary artery & brachial plexus. Am J of Anat 1939; 64:143-163.
14. Yuskel M, Yuskel R, Weinfield AB, et al. Superficial ulnar artery: embryology, case report and clinical significance in reconstructive microsurgery. J Reconstr Microsurg 1999; 15: 415-420.
15. Yang HJ, Gil YC, Jung WS, Lee HY. Variations of the superficial brachial artery in Korean cadavers. J Korean Med Sci 2008; 23: 884–887.
16. Kachlik D, Konarik M, Baca V. Vascular patterns of the upper limb: An anatomical study with accent on superficial brachial artery. Bosn J. Basic Med Sci 2011: 11: 4-10.
17. Anson BJ 'Human Anatomy In: The Cardiovascular System-arteries and veins. Thomas M. EDR. McGraw Hill Book C. Newyork 1966:762-64.
18. De Garis CF, Swartley WB. The axillary artery in white and Negro stocks. Am. J. Anat 1928; 41:353-97.
19. Compta XG. Origin of the radial artery from the axillary artery & associated hand vascular anomalies. J Hand Surg 1991; 16A:293-6.
20. Noguchi M, Hazama S, Tsukasaki S, et al. Iatrogenic pseudoaneurysm in a hemodialysis patient: the hidden hazard of a high radial artery origin. Heart Vessels 2004; 19:98-100.
21. Lo TS, Nolan J, Fountzopoulos E, et al. Radial artery anomaly and its influence on Transradial coronary procedural outcome. Heart 2009; 95:410-5.
22. Huber GC. Pierson's Human anatomy. In: The Vascular system 19th edition .JB Lippincott, Philadelphia 1930:767-791.

23. Bilodi AK, Sanikop MB. Variations in termination of brachial artery. A case report. Kathmandu University Medical Journal 2004; 2: 49-51.
24. Malcic-Gürbüz J, Gürünlüoğlu R, Ozdoğmuş O, et al. Unique case of trifurcation of the brachial artery: its clinical significance. Clin anat 2002 15:224-7.
25. Vollala VR, Nagabhooshana S, Bhat SM. Trifurcation of brachial artery with variant course of radial artery: Rare observation. Anat Sci Int 2008; 83: 307-309.