Singapore Med J 2012; 53(3) : 208

A morphological study of variations in the branching pattern and termination of the radial artery

Gupta C[1], MBBS, MD, *Ray B*[1], MBBS, MD, *Dsouza AS*[1], MBBS, MD, *Nair N*[1], MBBS, MD, *Pai SR*[1], MBBS, MD, *Manju M*[2], MBBS, MD

INTRODUCTION Coronary artery bypass grafting is an established means of treating advanced coronary artery disease. In recent years, there has been an increased interest in the radial artery as an entry route during coronary angiography. Accurate knowledge of the branching pattern of this artery and its relation to surrounding structures is of great importance in the care of surgical patients.

METHODS This study was conducted on 75 formalin-fixed upper limbs in order to note the variations in the branching pattern and termination of the radial artery.

RESULTS The radial artery divided into three branches in 2.7% of cases and into two branches in 52.0% of cases. The radial recurrent artery originated from the brachial artery instead of the radial artery in 12.0% of cases. The radial recurrent artery, palmar carpal artery, first dorsal metacarpal artery and superficial palmar artery were absent in 1.3%, 26.7%, 9.3% and 5.3% of cases, respectively. 6.7% of cases had a high origin of the superficial palmar artery.

CONCLUSION The rich photographic documentation of the variation of branching pattern and termination of radial artery is not only of academic interest but also useful to surgeons and radiologists working in the same area.

Keywords: branching pattern, coronary artery bypass grafting, radial artery, termination
Singapore Med J 2012; 53(1): 208–211

INTRODUCTION

The radial artery (RA) is smaller than the ulnar artery, but it is a more direct continuation of the brachial artery. It begins 1 cm distal to the bend of the elbow (i.e. at the level of the neck of the radius). At the level of the wrist, it is palpable between the flexor carpi radialis medially and the anterior border of the radius laterally. It then curls posterolaterally around the carpus, between the lateral carpal ligament and abductor pollicis longus and extensor pollicis brevis. It crosses the scaphoid bone and the trapezium (in the anatomical snuff box), and as it passes between the heads of the first dorsal interosseous, it is crossed by the tendon of the extensor pollicis longus. Between the thumb extensors, the RA is crossed by the cephalic vein and digital branches of the radial nerve, which supply the thumb and index finger. In the hand, it passes through the first interosseous space where it pierces the head of the first dorsal interossei muscle. Thereafter, it enters the palm deep to the oblique head of the adductor pollicis before passing between the two heads (oblique and transverse) of the adductor pollicis muscle.[1] The frequently observed branches of the RA in the forearm are the radial recurrent artery and muscular branches, and in the hand, the palmar carpal, superficial palmar, dorsal carpal, first dorsal metacarpal, arteria princeps pollicis and arteria radialis indices artery. The common mode of termination is formation of the deep palmar arch.

Coronary artery bypass grafting (CABG) is a well-known and familiar means of treating advanced coronary artery disease. Owing to its various anatomical and practical characteristics, the RA represents a likely conduit that may be both technically and clinically beneficial compared to other arterial grafts. Not only is it easily reachable due to its superficial course but its absence also does not lead to any haemodynamic disturbances owing to its compensatory succession by the ulnar artery. An increased awareness of the RA as an entry route during coronary angiography and percutaneous coronary interventions has been observed recently.

Most patients require grafting of three coronary systems, which need a full extent of the RA, i.e. approximately 20–24 cm in males and 2 cm less in females. Hence, the RA is harvested from its origin up to the wrist with a single incision. The left RA is harvested in right-handed individuals and vice-versa. The incision starts laterally, 2 cm above the wrist, and extends medially to the interline of the elbow. Anatomical variations of the RA require slight procedural changes.[2] An abnormality in the origin and course of the RA does not exclude it from being used as a graft; it necessitates minor changes in the operative procedure. The size of the artery always matches that of the coronary artery, except in some females (< 0.5%) who have severe hypogenesis and whose RA has a diameter < 1.5 mm despite spasm release manoeuvres, and this constitutes a contraindication.[2]

Accurate knowledge of the arterial anatomy of the upper extremities and its common variations is indispensable to limb surgeons. Awareness of variations in the upper extremity vasculature will help to prevent injury, thrombosis, gangrene and even amputation of limbs, especially in patients requiring dialysis

[1]Department of Anatomy, Kasturba Medical College, Manipal, India, [2]Department of Anatomy, Kasturba Medical College, Mangalore, India
Correspondence: Dr Chandni Gupta, Assistant Professor, Department of Anatomy, Kasturba Medical College, Manipal University, Manipal 576104, Karnataka, India. chandnipalimar@gmail.com

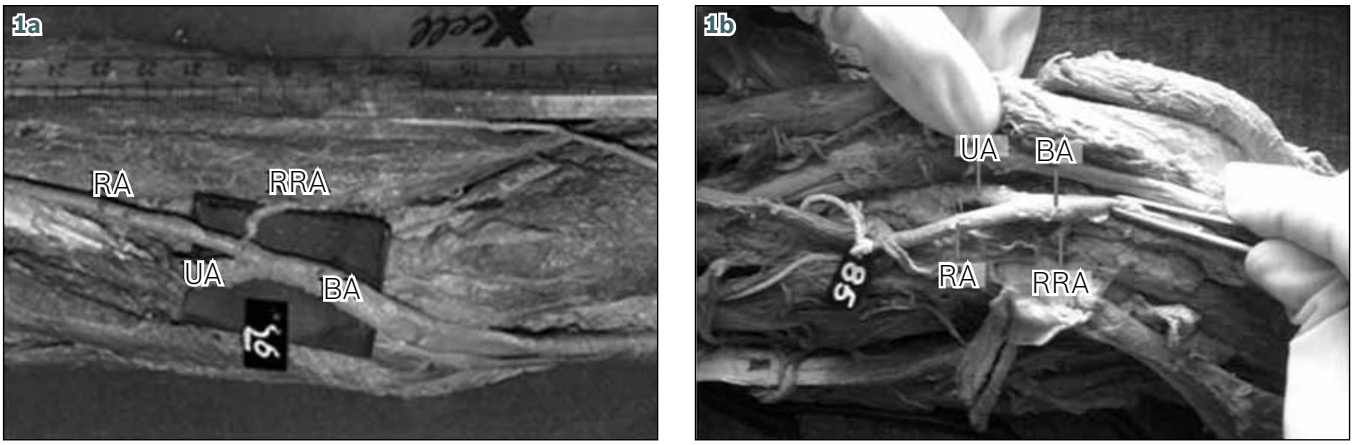

Fig. 1 Photographs show (a) normal origin of the radial recurrent artery from the radial artery; and (b) abnormal origin of the radial recurrent artery from the brachial artery. BA: brachial artery; UA: ulnar artery; RA: radial artery; RRA: radial recurrent artery.

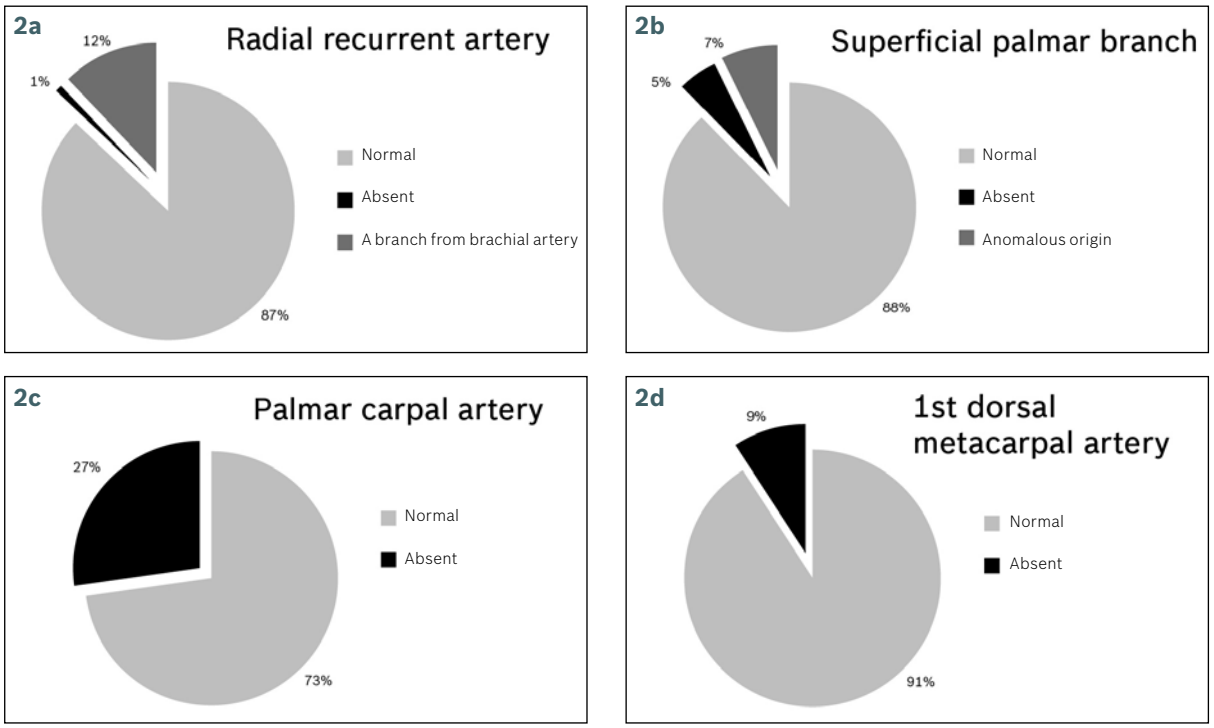

Fig. 2 Pie charts show the distribution of variations in the (a) radial recurrent; (b) superficial palmar; (c) palmar carpal; and (d) first dorsal metacarpal arteries in our study.

or undergoing arteriography. For both surgical and routine patient care, precise knowledge of the course of the RA and its relation to adjacent structures is of great importance. Therefore, the current study was undertaken to document and provide a database of both the normal and variant anatomies of the RA in adult human cadavers in the South Indian population.

METHODS

In this study, 75 formalin-fixed upper limbs were dissected. Out of these, 17 limbs were from male cadavers, nine were from female cadavers and 49 were isolated upper limbs. Upper limb specimens with damaged RAs were excluded from the study. An incision was made in the upper limb from the axilla up to the wrist, and the skin and deep fascia of the forearm from the axilla to the proximal margin of the flexor retinaculum were exposed in layers. A transverse incision was then made just proximal to the flexor retinaculum, and the flaps of fascia were reflected. The brachioradialis, tendons of the abductor pollicis longus and extensor pollicis brevis were retracted without any injury to the surrounding structures. In the groove between these muscles, the RA was identified and cleaned from its origin to its termination, and its branching pattern as well as any other variations were noted and recorded.

RESULTS

In nine out of the 75 cases (12.0%), the radial recurrent artery originated from the brachial artery instead of the RA (Fig. 1), and was absent in one case (1.3%) (Fig. 2). The palmar carpal artery was absent in 20 cases (26.7%) (Figs. 2 & 3), and the first dorsal metacarpal artery in seven (9.3%) (Figs. 2 & 4). In five out of the 75 cases (6.7%), the superficial palmar artery had a high origin of the radial (Fig. 3), while in four cases (5.3%), it was absent (Fig. 2). The princeps pollicis artery emerged from other arteries instead of from the RA in three cases (4.0%), from the median artery in one case (1.3%),

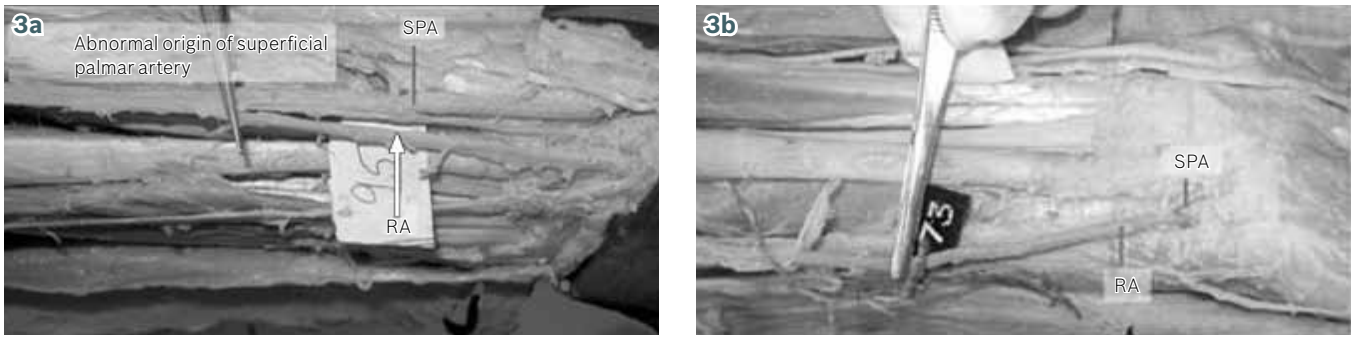

Fig. 3 Photographs show (a) anomalous high origin of the superficial palmar branch of the radial artery in the forearm; and (b) absent palmar carpal branch and normal superficial palmar artery. SPA: superficial palmar artery; RA: radial artery.

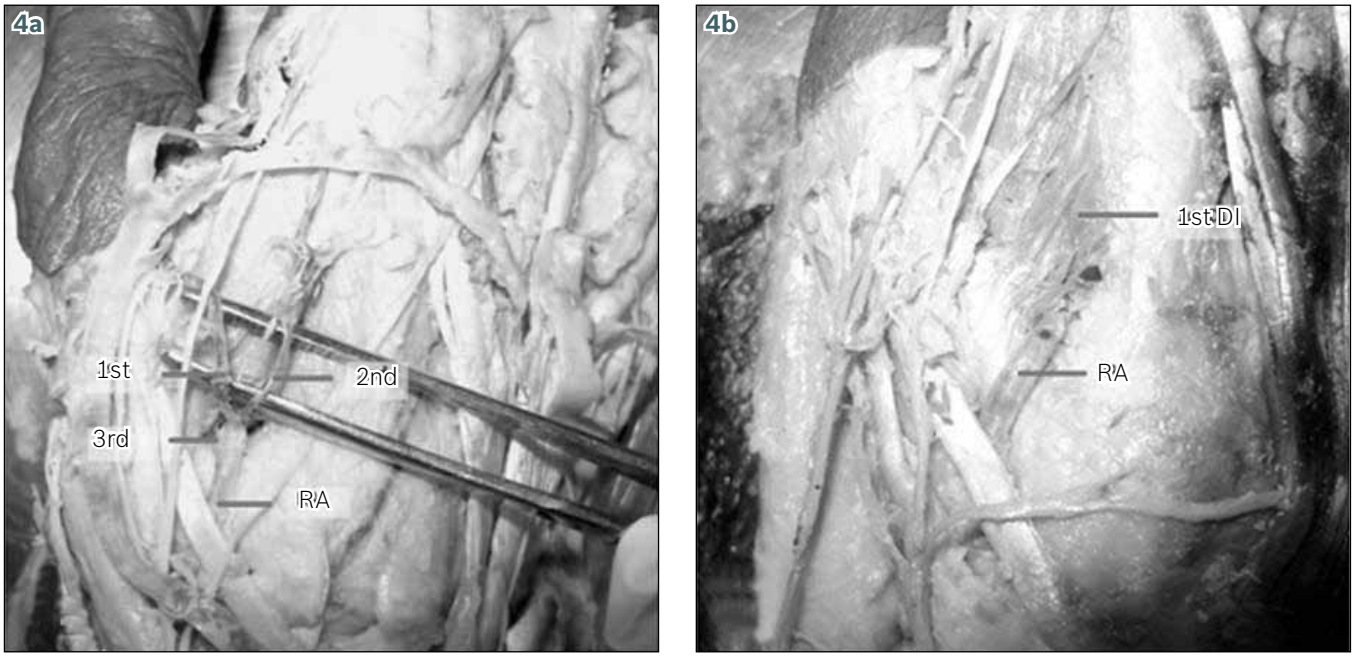

Fig. 4 Photographs show (a) the first dorsal metacarpal artery; and (b) absence of the first dorsal metacarpal artery. RA: radial artery; DI: dorsal interosseus muscle.

and from the superficial palmar branch of the RA in two cases (2.7%). In two cases (2.7%), the arteria radialis indicis emerged from the superficial palmar branch, and was absent in four cases (5.3%).

In two out of 75 cases (2.7%), the RA divided into three branches. The first branch gave off the princeps pollicis and radialis indices arteries from the web of the thumb, while the second branch was the dorsal metacarpal artery and the third was the deep branch of the RA. In 39 out of 75 cases (52.0%), two branches were observed; the first provided the princeps pollicis and radialis indices from the web of the thumb, and the second was the deep branch of the RA (Table I, Fig. 5).

Table I. Mode of termination of the radial artery.

Demographic	No. (%)
Normal	34 (45.33)
Dividing into 2 branches before piercing the dorsal interossei	39 (52.00)
Dividing into 3 branches before piercing the dorsal interossei	2 (2.66)

DISCUSSION

Variations in the arterial pattern of the upper limb have frequently been observed both in routine dissections and clinical practice. To our knowledge, this is the first study reporting unique variations in the branching pattern of the RA. In our study, the radial recurrent artery originated from the brachial artery instead of the RA in 12.0% of the cases, while in one specimen, it was completely absent. The palmar carpal artery was absent in 20 cases (26.7%) and the first dorsal metacarpal artery, in seven cases (9.3%). Dhar and Lall noted a case of superficial palmar artery arising high above from the RA,[3] which was also observed in five out of 75 cases (6.7%) in our study. However, in our study, the superficial palmar artery was absent in four cases (5.3%). Patnaik et al found that at the proximal end of the second intermetacarpal space, the RA gave off a second dorsal metacarpal branch that passed distally toward the second interdigital cleft,[4] whereas this was not observed in the present study.

Furthermore, de Rezende et al found termination of the RA by division into three branches in 22 specimens (84.6%).[5] However, division into three branches was noted in only 2.7% of our specimens, although the branches were similar (i.e. the princeps

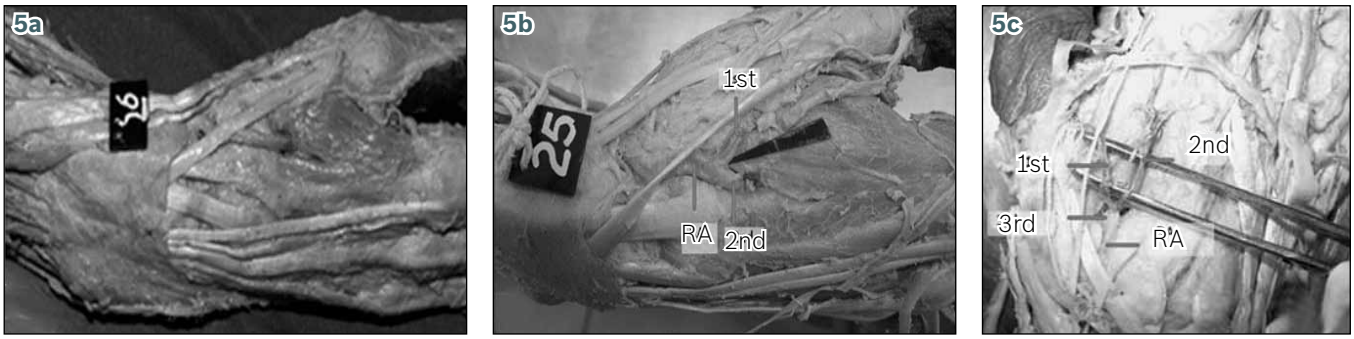

Fig. 5 Photographs show (a) normal; and (b & c) abnormal termination of the radial artery. (b) The radial artery is divided into two branches before termination; the first branch giving off the princes pollicis and the second forming the deep palmar arch. (c) The radial artery was divided into three branches before termination; the first branch giving off the princes pollicis, the second branch giving the first dorsal metacarpal artery and third forming the deep palmar arch. RA: radial artery

pollicis artery, first dorsal metacarpal artery and branch to the deep palmar arterial arch) (Fig. 5c). de Rezende et al also found termination of the RA by division into four branches, with the last branch running to the dorso-ulnar aspect of the thumb in 15.3% of specimens.[5] Of note, division of the RA into two branches was found in 39 out of the 75 cases (52.0%) in our study.

In conclusion, this extensive dissection-based study presented some distinctive and important findings on the branching pattern and termination of the RA, along with comparisons with previous reports. Such knowledge would be of immense help to surgeons and radiologists who are working on the RA as an entry route during coronary angiography and percutaneous coronary interventions.

REFERENCES

1. Standering S. The anatomical basis of clinical practice. In: Gray's Anatomy, 39th ed, London: Elsevier Churchill Livingstone, 2005: 867-78, 925-9.
2. Guo WH. Arterial grafting for coronary artery bypass surgery, 2nd ed. Berlin Heidelberg, Springer, 2006: 151-5.
3. Dhar P, Lall K. An atypical anatomical variation of palmar vascular pattern. Singapore Med J 2008; 49:e245-9.
4. Patnaik VVG, Kalsey G, Singla KR. Anomalous course of radial artery and a variant of deep palmar arch – a case report. J Anat Soc India 2000; 49:54-7.
5. de Rezende MR, Mattar Júnior R, Cho AB, Hasegawa OH, Ribak S. Anatomic study of the dorsal arterial system of hand. Rev Hosp Clin Fac Med Sao Paulo 2004; 59:71-6.