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Original Research

Morphological and Topographical Features of the Radial Recurrent Artery and Its Possible Clinical Significance

Latif Sağlam[1], Özcan Gayretli[1], Osman Coşkun[1], İlke Ali Gürses[2], Buse Naz Çandır[3], Ayşin Kale[1], Adnan Öztürk[4]

[1]Department of Anatomy, Istanbul Faculty of Medicine, Istanbul University, Istanbul, Turkey
[2]Department of Anatomy, School of Medicine, Koç University, Istanbul, Turkey
[3]Department of Anatomy, Faculty of Medicine, Istanbul Yeni Yüzyıl University, Istanbul, Turkey
[4]Department of Anatomy, Faculty of Medicine, Istanbul Health and Technology University, Istanbul, Turkey

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Correspondence

Latif Sağlam,
Address: Department of Anatomy, Istanbul Faculty of Medicine, Istanbul University, Millet Caddesi, Fatih, 34093 Istanbul, Turkey.
E-mail: latif.saglam@istanbul.edu.tr

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ABSTRACT

Objective: The anatomy of the radial recurrent artery (RRA) is very important for interventional procedures. The aim of this study was to investigate the morphological and topographic anatomy of the RRA.

Methods: The study was conducted on 20 human cadavers (14 males and 6 females, 40 upper limbs). The RRA was classified into 4 groups as follows according to the observed origin: RRA originated from the radial artery (RA) (Type A), the root of the RA (Type B), the brachial artery (BA) (Type C), and the ulnar artery (UA) (Type D). The relative positioning of the RRA in relation to the tendon of the biceps brachii muscle (TBB), in terms of the antero-posterior direction, was determined. The vertical distance of the origin point of the RRA to the intercondylar line and the diameters of this artery were determined. Morphometric evaluation was performed with a digital caliper. The obtained data were analyzed using SPSS version 21.00 software.

Results: The artery most commonly originated from the RA (Type A 47.5%, 19 extremities). This was followed by RA root (Type B 32.5%, 13 extremities), BA (Type C 17.5%, 7 extremities), and UA (Type D 2.5%, 1 extremity). The RRAs coursed anteriorly to the TBB in 38 extremities (95%) and passed behind the tendon in 2 extremities (5%). The vertical distance of the origin point of the RRA to the intercondylar line was meanly 32.20 ± 6.86 mm. The diameter of the artery at its origin point was meanly 2.57 ± 0.58 mm and just after its first branch was meanly 2.05 ± 0.48 mm. Our study documents a rare morphological variation of the RRA originating from the UA (Type D).

Conclusion: While many of our findings align with previous studies, this research presents novel anatomical findings and elucidates the superficial course and topographical positioning of the RRA to estimate its origin point.

Keywords: Radial recurrent artery, morphology, morphometry, anatomy, clinical significance

INTRODUCTION

The anatomy of the RRA is important in clinical applications such as plastic and reconstructive surgery, interventional radiology, and microsurgery used in the elbow area and forearm [1, 2]. It was reported that the RRA can be used as a fasciocutaneous flap in soft tissue defects occurring around the elbow joint, traumas, and burns, as well as a free fasciocutaneous or fascial flap in surgeries of the head and neck area [1, 3-5].

It was also reported that the RA is used as a graft in coronary artery bypass surgery and that the proximal border of this graft is determined by the origin of the RRA [6, 7]. It was shown previously that RRA can develop after RA graft removal and can feed the areas where the RA is distributed in the forearm [7].

Abnormal new vessels might develop from the RRA in some patients with chronic lateral epicondylitis. It is considered that these abnormal vessels might be the source of chronic pain. In such instances, the RRA can be considered as the target artery for transcatheter arterial embolization in therapeutic procedures [8, 9].

Another clinical aspect of the RRA pertains to its proximity to the tendon of the biceps brachii muscle (TBB). Based on this neighborhood, it was emphasized that the RRA should be considered in open surgeries involving the TBB [10]. Additionally, the RRA plays a vital role in terms of the anastomosis with the radial collateral branch of the deep brachial artery. This anastomosis can serve as an alternative blood supply to the forearm in case of BA occlusion [11].

Although the RRA is frequently utilized in clinical practice, the frequency of its variations [1] can significantly impact the safety and success of clinical applications associated with this artery [12-14]. Therefore, it can be reasonably hypothesized that the safety and success of any interventional procedure involving the RRA are contingent on a comprehensive understanding of the variations in this artery. In this context, the purpose of this cadaveric study is to discuss the morphological features of RRA and explore its topographic and superficial anatomy to elucidate the possible relationships with relevant clinical practice.

Main Points;

- The anatomy of the radial recurrent artery is very important for interventional procedures.
- With this study, we aimed to investigate the morphological and topographic anatomy of the radial recurrent artery.
- The artery most commonly originated from the radial artery (Type A 47.5%, 19 extremities).
- The vast majority of the radial recurrent arteries (38 extremities) coursed anteriorly to the tendon of biceps brachii muscle.
- The vertical distance of the origin point of the radial recurrent artery to the intercondylar line was meanly 32.20 ± 6.86 mm.
- A rare morphological variation of the radial recurrent artery originating from the ulnar artery (Type D) was observed in the current study

MATERIALS AND METHODS

Examinations of the RRAs were conducted on 40 samples (20 right and 20 left) of the upper extremities of the 20 human cadavers, which had been preserved using a mixture of formaldehyde, phenol, ethyl alcohol, glycerin and water. The cadavers were sourced from the Department of Anatomy at Istanbul University's Istanbul Faculty of Medicine. These cadavers had been previously utilized for dissection training for medical students between 2006 and 2017.

Six of these cadavers were female, 14 were male, and the ages ranged between 49 and 88 years. Two experienced anatomists (L.S. and O.G.) dissected the cadavers and carried out the evaluation of anatomical parameters. There was no gross pathology and/or deformity in any of the cadavers that might affect the measurements. Ethical approval for the study was granted by the Clinical Research Ethical Committee of Istanbul Faculty of Medicine of Istanbul University (IRB (Institutional Review Board) number: 2017/1121).

Dissection Procedure

The extremities were fixed with the elbow in extension and the forearm in the supine position as much as possible. Two skin incisions (each approximately 15 cm in length) were made from medial to lateral (approximately 5 cm proximal and distal to the elbow joint) and transverse to the extremity. The lateral ends of these incisions were combined with a third incision parallel to the long axis of the extremity and the skin in this region was carefully elevated medially. The superficial veins and superficial nerves were dissected in the subcutaneous tissue. The deep fascia and bicipital aponeurosis were dissected, and the BA, brachial veins, and the median nerve were uncovered just below. The division of the BA into its two terminal branches was determined by tracing its course. The deep veins that accompanied the brachial, ulnar, and radial arteries were carefully separated from the arteries and removed. Using classical anatomical landmarks, the RRA that proceeded between the superficial and deep branches of the radial nerve and ascended between the brachioradialis and brachialis muscles superficially to the supinator muscle was identified. The morphology of the RRA was uncovered by following the trace of the RRA upward to the lateral epicondyle.

Morphological Evaluation

Each RRA was evaluated morphologically, and the subsequent classification was established based on the observed variations [5].

- Type A: RRA originates from the RA (see **Figure 1**)
- Type B: RRA originates from the root of the RA (see **Figure 2**)
- Type C: RRA originates from the BA (see **Figure 3**)
- Type D: RRA originates from the ulnar artery (UA) (see **Figure 4**)

Also, the relative positioning of the RRA in relation to the biceps brachii muscle tendon, in terms of the antero-posterior direction, was determined.

Morphometric Evaluation

- Vertical distance of the origin points of the RRA to the intercondylar line (DICL) (see **Figure 5**)
- Forearm length (FL): The perpendicular distance between the lateral epicondyle and the styloid process of the radius was measured (see **Figure 5**) and the ratio of DICL to FL was calculated.
- Perpendicular distance of the origin of the RRA to the point of bifurcation of the BA (DBA=Distance to BA) (see **Figure 5**). Please note that this distance was not measured when the RRA originated from the root of the RA.
- Diameter of the RRA at its origin (DRRA1=Diameter of RRA's origin) and the diameter immediately after it gave its first branch (DRRA2= Diameter of RRA after second branch) (see **Figure 5**).

Morphometric assessments were performed by using a digital caliper (Mitutoyo Company, Kawasaki-shi, Kanagawa, Japan). The widest transverse distance was employed as the reference when measuring the arteries diameters.

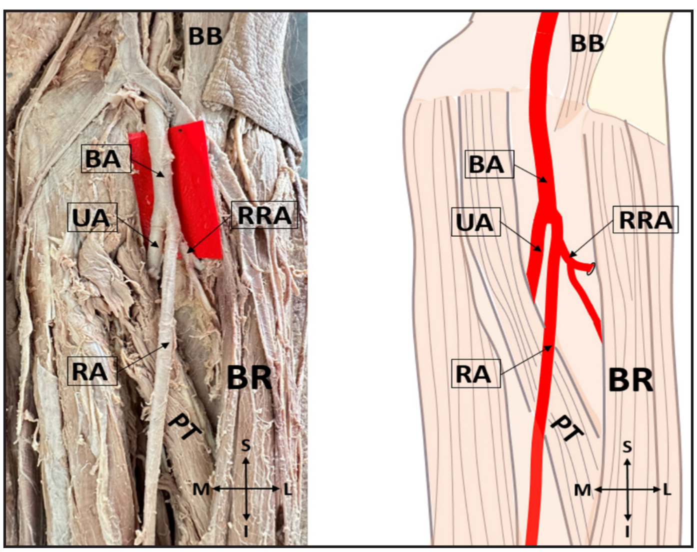

Figure 1. Radial recurrent artery originating from the radial artery (Type A) in the cadaver on the left side and its schematic illustration on the right (anterior view, left). Brachial artery *(BA)*, radial artery (*RA*), ulnar artery (*UA*), radial recurrent artery (*RRA*), biceps brachii muscle (*BB*), brachioradialis muscle (*BR*), pronator teres muscle (*PT*), and directional references (*M* for medial, *L* for lateral, *S* for superior, *I* for inferior).

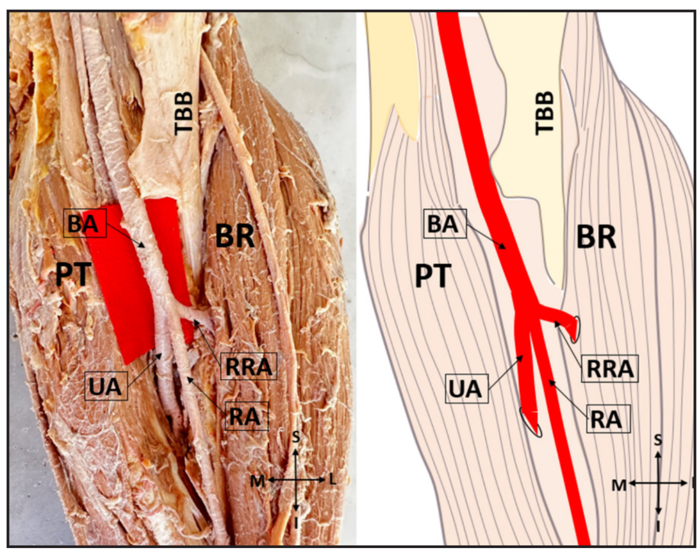

Figure 2. Radial recurrent artery originating from the root of the radial artery (Type B) in the cadaver on the left side, and its schematic illustration on the right (anterior view, left). Brachial artery (*BA*), radial artery (*RA*), ulnar artery (*UA*), radial recurrent artery (*RRA*), tendon of biceps brachii muscle (*TBB*), brachioradialis muscle (*BR*), pronator teres muscle (*PT*), and directional references (*M* for medial, *L* for lateral, *S* for superior, *I* for inferior).

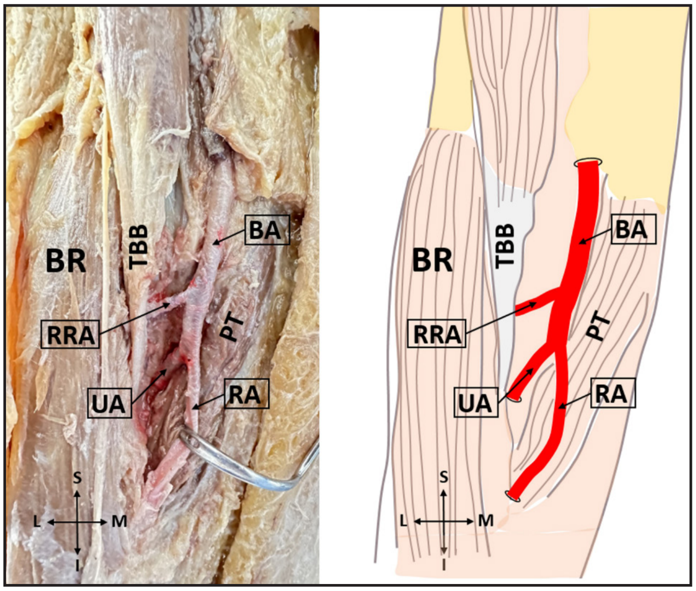

Figure 3. Radial recurrent artery originating from the brachial artery (Type C) in the cadaver on the left side, and its schematic illustration on the right (anterior view, right). Brachial artery (*BA*), radial artery (*RA*), ulnar artery (*UA*), radial recurrent artery (*RRA*), tendon of biceps brachii muscle (*TBB*), brachioradialis muscle (*BR*), pronator teres muscle (*PT*), and directional references (*M* for medial, *L* for lateral, *S* for superior, *I* for inferior).

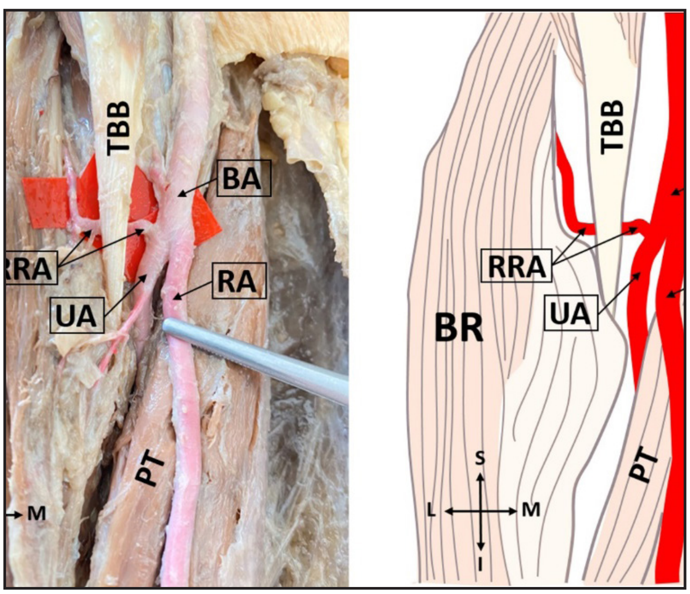

Figure 4. Radial recurrent artery originating from the ulnar artery (Type D) in the cadaver on the left side, and its schematic illustration on the right (anterior view, right). Brachial artery (*BA*), radial artery (*RA*), ulnar artery (*UA*), radial recurrent artery (*RRA*), tendon of biceps brachii muscle (*TBB*), brachioradialis muscle (*BR*), pronator teres muscle (*PT*), and directional references (*M* for medial, *L* for lateral, *S* for superior, *I* for inferior). Please note that the radial artery was replaced medially from its normal anatomical position for the photography.

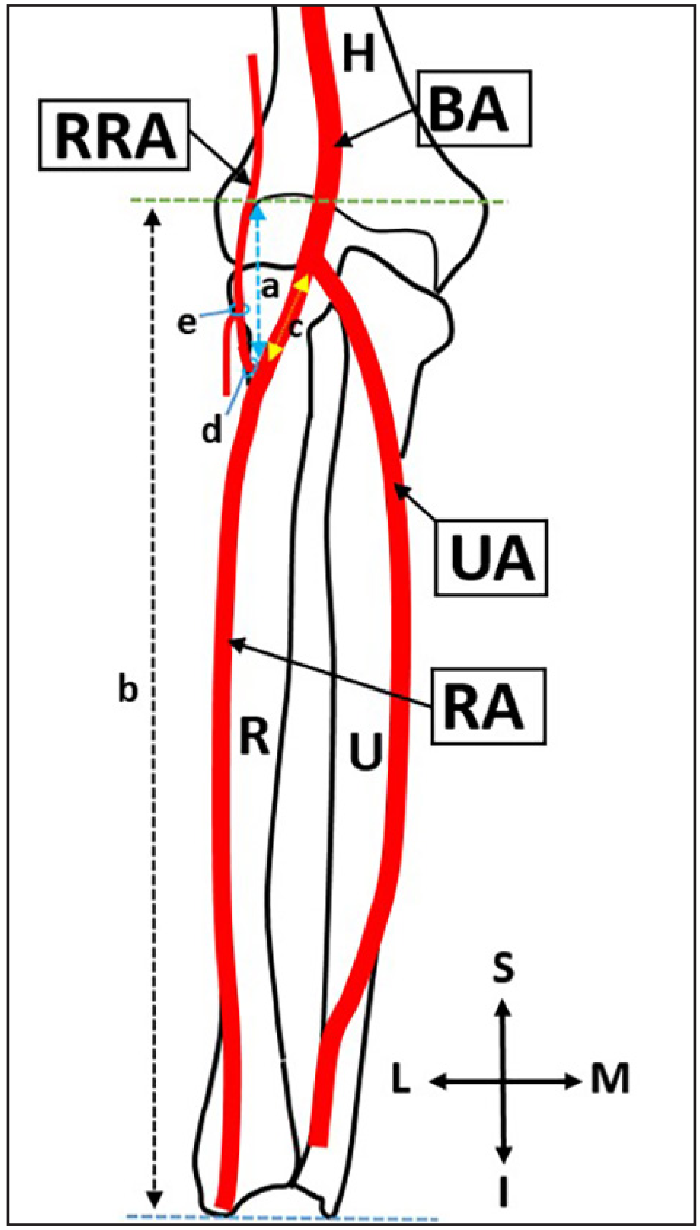

Figure 5. A schematic illustration of morphometric measurements related to the radial recurrent artery (anterior view, right). Brachial artery (*BA*), radial artery (*RA*), ulnar artery (*UA*), radial recurrent artery (*RRA*), labeled measurements including the vertical distance of the origin point of RRA to the intercondylar line (*a, DICL*), the perpendicular distance between the lateral epicondyle and the styloid process of the radius (*b, FL*), the perpendicular distance of the origin of the RRA to the point of bifurcation of the brachial artery (*c, DBA*), the diameter of the RRA at its origin (*d, DRRA1*), the diameter of the RRA just after its first branch (*e, DRRA2*), humerus (*H*), radius (*R*), ulna (*U*), and directional references (*M* for medial, *L* for lateral, *S* for superior, *I* for inferior), the dotted green line represents the intercondylar line and the dotted blue line indicates the line passing transversely from the styloid process of the radius.

Statistical Evaluation

The SPSS version 21.00 (IBM Corp.) software was used in the statistical analysis of the categorical and measurement values. Frequency (n) and percentage (%) values were used for categorical variables. Descriptive statistics such as mean and standard deviation were applied for the variables in the measurements. The Shapiro-Wilk Test was used to test whether the measured values were normally distributed. Following this test, the student t-test was used to compare the normally distributed data concerning side and gender groups with the relevant group.

The Mann-Whitney U-Test was used to compare non-normally distributed data among side and gender groups with the relevant groups. The Kruskal-Wallis Analysis of Variance was used to evaluate the DRRA1 value according to Types (A, B, C, D). Note that the Type D variable was excluded from the analysis due to the presence of only one side in the Type D.

RESULTS

Morphological Features

No aneurysms or structural abnormalities were detected in the BA, RA, UA, or RRA. The distribution of RRAs by type was as follows. Type A, 47.5% (19 extremities); Type B, 32.5% (13 extremities); Type C, 17.5% (7 extremities); and Type D, 2.5% (1 limb). The distribution of numbers and frequency of types of RRA in terms of gender and side is shown in Table 1. RRAs coursed anteriorly to the TBB in 38 extremities (95%) and passed behind the tendon in 2 extremities (5%).

Table 1. Distribution of numbers and frequency of types of the radial recurrent artery (RRA) in terms of gender and side

	n (side)	Type A	Type B	Type C	Type D
Male	28	14 (50%)	11 (39.3%)	2 (7.%)	1 (3.6%)
Female	12	5 (41.7%)	2 (16.6%)	5 (41.7%)	-
Right	20	11 (55%)	6 (30%)	3 (15%)	-
Left	20	8 (40%)	7 (35%)	4 (20%)	1 (5%)
Total	40	19 (47.5%)	13 (32.5%)	7 (17.5%)	1 (2.5%)

Type A: RRA originates from the radial artery, **Type B**: RRA originates from the root of the radial artery, **Type C**: RRA originates from the brachial artery, **Type D**: RRA originates from the ulnar artery

Table 2. The values obtained according to the sides

	Right Side (n=20) (mm)		Left Side (n=20) (mm)		
Parameters	**Mean**	**± SD**	**Mean**	**± SD**	**P value**
DICL	32.82	8.33	31.59	5.15	0.57
FL	254.63	18.15	251.51	16.62	0.57
DRRA2	2.11	0.55	2.00	0.40	0.48
	Median	**Min-Max**	**Median**	**Min-Max**	**P value**
DBA[a]	3.35	0.00-11.89	3.55	0.00-28.00	0.74
DRRA1[a]	2.55	2.03-3.78	2.54	1.59-3.44	0.30

[a]Median and minimum (min) / maximum (max) values are given for values that did not have a normal distribution for the sides.
mm: millimeter; **DICL**: The vertical distance of the origin point of the radial recurrent artery (RRA) to the intercondylar line; **FL (Forearm length):** The perpendicular distance between the lateral epicondyle and the styloid process of the radiu; **DRRA2**: The diameter of the RRA immediately after it gives its first branch; **DBA**: The perpendicular distance of the origin of the RRA to the point of bifurcation of the brachial artery; **DRRA1**: The diameter of the RRA at its origin; **SD**: Standard deviation

Morphometric Features

The mean DICL, FL, and DBA were 32.20 ± 6.86 mm, 253.07 ± 17.25 mm, 4.06 ± 4.01 mm, respectively. Similarly, the mean DRRA1 and DRRA2 were 2.57 ± 0.58 mm and 2.05 ± 0.48 mm, respectively. Comparisons based on sides are presented in Table 2, and comparisons based on gender are shown in Table 3. The calculated ratio of DICL value to FL was calculated as 1:7.85. Since p=0.88 was detected in the evaluation of DRRA1 value according to Types (A, B, C, D), no significant differences were observed in this regard (p> 0.05). Furthermore, the number of samples was small in our study, and no statistically significant differences were detected in the comparison of the sides and genders in almost all the morphometric data.

DISCUSSION

Morphological Features

Types of RRA

When the studies in the literature conducted on RRA were reviewed, it was found that there was no standard among researchers (Table 4). Type A, Type B, Type C, and Type D morphological properties were detected at the highest rates, respectively, by Gupta et al. [15], Zeltser and Strauch [10], Nasr [16], and Zeltser and Strauch [10]. In the present study, RRA in Type A, Type B, Type C, and Type D morphology was found to be 47.5% (19 out of 40 extremities), 32.5% (13 out of 40 extremities), and 17.5% (7 out of 40 extremities), respectively and 2.5% (1 in 40 extremities).

Although it was found that our RRA value in Type A morphology was close to the results of the study conducted by Zeltser and Strauch [10], our results regarding Type B RRA origin were similar and compatible with those reported by Hamahata et al. [5]. However, the rate of Type C RRA in our study represents the highest value in the literature and differs from previous findings. For instance, Adachi [17] reported that the RRA was separated from the BA or superficial brachial artery in 25 of 311 upper extremities (8.03%), and the RRA was separated from the distal border of the BA or superficial brachial artery in 15 upper extremities (4.82%). We did not encounter the superficial brachial artery mentioned by Adachi [17] in our study.

The rate of Type D RRA morphology in our study did not align with the results reported by Hamahata et al. [5], or Zeltser and Strauch [10]. The reason why our RRA results in Type C and Type D morphological features were incompatible with previous studies might be that these studies were conducted on samples from different races and/or the sample populations. Some interpretation differences in morphological classifications might also affect the results of the studies. For example, Adachi [17] introduced three subgroups for the classification of Type B RRA origin while Vazquez et al. [1] did not observe this variation in their study. The variation in findings by Vazquez et al. [1] may be attributed to the grouping of Type B and Type A origins together. In their study conducted on 120 upper limbs, Haładaj et al. [18] observed that RRA originated from the radial artery in 81.6%, the posterior radioulnar division (called "trifurcation of the brachial artery") in 9.2%, the brachioradial artery (radial artery of high origin) in 5%, and the cubital crossover (anastomosis between the brachioradial and "normal" brachial artery) in 4.2%. We did not observe the posterior radioulnar division, brachioradial artery, or cubital crossover in our study. We think that the possible reason is due to the small sample size in the study.

Hamahata et al. [5] reported that they used the free RA flap, modified with RRA, in their facial salvage operations. According to their findings, Type A group of RRAs was preferred for this flap type due to its ease of dissection. The Type B was the second most preferred, as it required careful surgical incision and sutures to protect the separation site. They also reported that RRAs with Type C and Type D morphology were unsuitable for surgical operations. In our study, the RRA rate in Type C and Type D morphological features was higher than those reported by Hamahata et al. [5], and therefore, we believe that RRAs with these morphologies are less likely to be used in facial surgical operations of this kind.

The RA can be used as a graft in coronary artery bypass surgery [6, 7]. The origin point of RRA is the proximal border of the RA graft [6, 7]. Given our observation of RRAs with Type C and Type D morphological characteristics that do not originate from the RA, it is crucial for surgeons to be aware of these potential variations when utilizing the RA as a graft in coronary artery bypass surgery. Failure to recognize such variations could result in inadvertent dissection of the BA, as the proximal border might be challenging to ascertain in these cases. Awareness of these anatomical nuances is essential to ensure the success and safety of surgical procedures involving the RA graft.

Relationship of RRA with the TBB

It is important that there are very few studies that evaluated the relationship between the RRA and the TBB, and that their results are not consistently aligned. Adachi [17]'s study on 311 upper

Table 3. The values obtained according to the gender

	Male (n=28) (mm)		Female (n=12) (mm)		P value
Parameters	**Mean**	**± SD**	**Mean**	**± SD**	
FL	258.50	15.15	240.40	15.55	0.001*
DRRA1	2.66	0.60	2.34	0.49	0.11
DRRA2	2.15	0.51	1.83	0.31	0.05
	Median	**Min-Max**	**Median**	**Min-Max**	**P value**
DICL[a]	31.75	10.49-41.54	32.10	18.70-47.92	0.59
DBA[a]	2.84	0.00-28.00	4.37	0.00-12.38	0.99

[a]Median and minimum (min) / maximum (max) values are given for values that did not have a normal distribution.

*A statistically significant difference was detected when comparing FL values according to gender (**p<0.001**).

mm: millimeter; **SD:** Standard deviation; **FL (Forearm length)**: The perpendicular distance between the lateral epicondyle and the styloid process of the radius; **DRRA1**: The diameter of the RRA at its origin; **DRRA2**: The diameter of the RRA immediately after it gives its first branch; **DICL**: The vertical distance of the origin point of the radial recurrent artery (RRA) to the intercondylar line; **DBA**: The perpendicular distance of the origin of the RRA to the point of bifurcation of the brachial artery.

Table 4. Studies conducted on radial recurrent artery in the present and previous reports

Studies	Sampling Count (Sides)	Place of the Study	Type A		Type B		Type C		Type D	
			Side	Percentage (%)	Side	Percentage (%)	Side	Percentage (%)	Side	Percentage (%)
[a]**Adachi [17]**	311	Japan	231	74.27%	32	10.28%	40	12.86%	0	0%
[b]**Gupta et al. [15]**	75	North India	65	87%	0	0%	9	12%	0	0%
[c]**Nasr [16]**	100	N/A	83	83%	0	0%	15	15%	0	0%
Hamahata et al. [5]	18	Japan	11	61%	6	33.3%	0	0%	1	5.6%
[d]**Vasquez et al. [1]**	332	N/A	215	64.8%	0	0%	24	7.2%	0	0%
Zeltser and Strauch [10]	17	N/A	7	44%	9	55%	0	0%	1	5.8%
[e]**Haładaj et al. [18]**	120	N/A	98	81.6%	-	-	-	-	-	-
Our Study	40	Turkey	19	47.5%	13	32.5%	7	17.5%	1	2.5%

Type A: RRA originates from the radial artery; **Type B:** RRA originates from the root of the radial artery; **Type C:** RRA originates from the brachial artery; **Type D:** RRA originates from the ulnar artery.

[a]Adachi (1928) divided the 32 limbs into 3 subgroups those separated from the proximal part of the root of the radial artery (16 limbs), those separated from the level of the radial artery (13 limbs), and those separated from the distal part of the root of the radial artery (3 limbs).

[b]Gupta et al. (2012) reported no RRAs on one side (1.3%).

[c]Nasr (2012) reported no RRAs on 2 sides (2%).

[d]Vasquez et al. (2013) reported that there were RRAs that did not fit the types reported above.

[e]Haładaj et al. (2018) reported that the RRA originated from the posterior radioulnar division (called "trifurcation of the brachial artery") in 9.2% (11/120), directly from the brachioradial artery in 5% (6/120), and the cubital crossover in 4.2% (5/120).

extremities, for instance, found that the RRA passed in front of the TBB in 80.06% of cases and behind the TBB in 17.36% of cases. He also emphasized that the RRA, which separates from the RA or the level of origin of the RA, always passes in front of the TBB. He pointed out that in other cases that originate from the root (separated from the proximal root of the RA or the distal part of the root of the RA), the RRA always passes behind the TBB.

In a study involving 332 upper extremities, Vazquez et al. [1] reported that the RRA was localized in front of the TBB in 91.26% of cases with the remaining 8.73% showing the RRA behind the TBB. Another study conducted by Zeltser and Strauch [10] showed very well the relationship of the BA, the RA and its recurrent branches, and venous branches with the TBB. Zeltser and Strauch [10] reported in their study conducted on 17 cadaveric upper extremities that they detected main RRA and additional RRA. They noted that in cases with a single RRA, all of them crossed the TBB anteriorly, whereas in samples with additional RRAs, 47% (8 of 17 sides) crossed the TBB posteriorly.

In the present study, we observed that the RRA passed in front of the TBB in 95% of the examined extremities, while in 5% of cases, it passed and behind the tendon. The presence of additional RRA was not evaluated in our study.

The values obtained in the present study are not compatible with the values reported in the literature. The reason for this discrepancy might be that previous studies were conducted in different races and/or differences in sample populations. Bone protrusions, muscles, tendons, and even muscle fibers can be used as guides in invasive procedures [19, 20]. In this context, the TBB may serve as a good landmark when harvesting RRA flaps. According to the results of the present study, although it was found that the majority of the RRA passes in front of the TBB, a significant part of it passes behind the tendon (5%). In this respect, we think that knowing this when harvesting the RRA flap might facilitate invasive procedures and help prevent potential complications in the area, such as unanticipated bleeding.

Morphometric Features

In their case report, Wysiadecki et al. [2] and Patnaik et al. [21] reported DICL values of 39 mm and 30 mm, respectively. No other data on DICL values were found in the literature. In the present study, the average DICL was determined to be 32.20 ± 6.86 mm, a result largely consistent with previous studies. According to our findings, the origin of the RRA is situated approximately 3 cm distal to the intercondylar line. This suggests that our average DICL value may serve as a valuable reference for clinicians in locating the origin of the artery during interventional procedures involving the RRA.

The average FL value in our study was measured at 253.07 ± 17.25 mm. A statistically significant difference was observed when comparing FL values by gender ($p=0.0003$). The ratio of DICL value to FL was calculated as 1:7.85. This ratio indicated that, the origin of the RRA corresponds to roughly 1/8 of the proximal FL. Such a ratio was not found in the existing literature. We believe that this ratio holds practical value for estimating the RRA's origin quickly and superficially.

In the literature, only one study by Zeltser and Strauch [10] was identified regarding the DBA value. Their study, conducted on 17 upper extremities, reported an average DBA value of 2 mm in 2 extremities, 5 mm in 4 extremities, and 7.6 mm in 2 extremities. In the present study, the researchers found the average DBA value to be 4.06 ± 4.01 mm. We think that knowing the average DBA value might help surgeons in terms of preserving the RRA because the RRA origin point determines the proximal border when harvesting the radial artery graft for coronary artery bypass surgery [6, 7]. We also believe that this value might be important in terms of practically detecting the origin point of the RRA. In other words, we believe that the RRA is easily accessible at a distance of approximately 0.5 cm distal to the RA after the BA and RA have been identified during surgery.

In the present study, we measured the diameter of the RRA from two different points, DRRA1 and DRRA2, resulting in measurements of 2.57 ± 0.58 mm and 2.05 ± 0.48 mm, respectively. In their study on 18 upper extremities, Hamahata et al. [5] calculated the average diameter of the RRA at a distance of 20 mm from the bifurcation of the RA as 1.84 ± 0.59 mm and emphasized that the most suitable point for dissection of the artery was 20 mm from the bifurcation of the RA, and the artery gave off some branches after 20 mm. There is a discrepancy between the results of the present study and the study of Hamahata et al. [5]. The reason for this might be that the diameter measurements of the RRA were made more proximally and/or the samples studied belonged to different races in the present study.

Luther et al. [22] identified 32 transradial neurointerventions (TRA) in which patients had radial artery loops. They found that patients with smaller caliber RRAs (RRA diameters ≤2 mm) were more prone to TRA failure in the presence of a radial artery loop. In this context, considering that our average RRA1 and RRA2 values were greater than 2 mm, it can be said that TRA can be successful in the presence of a radial artery loop. We would not have knowledge of whether our cadavers had radial artery loops or not. So, we could not make any comment. Consequently, the mean RRA1 and RRA2 values may be important in predicting TRA failure in the presence of a radial artery loop.

No statistically significant differences were detected in the comparison of the sides and genders in almost all the morphometric data (the number of samples was small). We think that the lack of such a difference might mean that invasive procedures for the RRA can be performed irrespective of side and gender.

Limitations

The most important limitation of this study was that it had a small size sample (20 cadavers). Therefore, we think that we could not observe the variations reported in the literature (posterior radioulnar division, brachioradial artery, etc.). If we had studied a large sample size, we could have observed many variations of RRA. Additionally, statistical analysis could have been more meaningful.

The fact that the study was conducted on embalmed cadavers previously used in dissection training of medical students can be considered as one of the limitations. Although this does not mean that the results of the study are not valid, fresh frozen cadavers or fresh unembalmed cadavers may provide more objective data. The ages of the specimens included in the study can also be considered among the limitations. Our findings were obtained from cadavers ages ranged between 49 and 88 years. Therefore, we do not know whether the findings we observed are age-related. Our results could have been more meaningful if the study had been conducted in a balanced age group (for example, ages ranged between 30 and 40 years). Moreover, we did not have a clinical presentation of the specimens. If we had, it would be valuable to reveal their relationship with the clinical presentation.

CONCLUSION

The present study investigated the morphological characteristics, topographic anatomy and superficial projection of the RRA. Unlike previous studies, the present study documented the existence of a rare morphological variation of Type D, originating from the UA. The prevalence of RRAs passing in front of the TBB is higher than in previous literature. Also, the study expanded upon the available morphometric data for RRAs, offering a more comprehensive understanding of this artery's anatomical features. By analyzing the collected data according to sides and genders, the study provides a nuanced perspective on the variations and relationships between different morphological and morphometric characteristics of the RRA.

Finally, the study described the topographic location of the superficial projection of the RRA in relation to the intercondylar line and forearm length, facilitating a practical estimation of its origin. These findings contribute to the broader understanding of the RRA's anatomical features and may aid clinicians and surgeons in various medical interventions involving the RRA. Overall, this study sheds light on previously unexplored aspects of the RRA, enhancing our knowledge of its anatomical variations and clinical relevance.

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