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Research Article - Basic and Applied Anatomy

Pattern of variations in superficial palmar arch in 134 Negro cadaveric hands

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Abstract

Objective: To investigate the incidence of anatomical variations of superficial palmar arch in Negro population. **Materials and method**: A total of 134 upper limbs comprising 74 right and 60 left specimens embalmed with formaldehyde were used for the investigation. The hand was dissected with palmar aponeurosis identified and removed to expose the ulnar and radial arteries. **Results**: A complete superficial arch was observed in 73.9 % specimens. In 70.1 % cases the superficial branch of the ulnar artery communicated with its radial arterial counterpart. In 3.0 % cases the arch was formed entirely by the ulnar artery while in a single case (0.8 %), a rare pattern was observed in which the superficial palmar branch of the ulnar artery gave rise to the princeps pollicis artery as its terminal branch with the exclusion of radialis indicis that had its origin from deep palmar branch of radial artery. The incomplete arch constituted 26.1 % of the entire palmar arch formation. **Conclusion**: In our Negro population study, deviation from normal anatomical pattern was common. Therefore, a review of vascular pattern prior to invasive or intervention surgery is strongly recommended to be able to detect anomalies likely to necessitate modification of surgical procedures.

Key words

Hand palm, superficial arch, variations, African population.

Introduction

The vascular anatomy of the hand is challenging due to a high prevalence of previously identified variations (Bianchi, 2001; Gellman et al., 2001; Valeria et al., 2004). These variations were usually found in the palmar arches of which the superficial palmar arch (SPA), through which the hand receives its major blood supply, has been shown to be more variable (Ikeda et al., 1988; Bianchi, 2001). The SPA has been described to be broadly divided into two categories: complete and incomplete. The difference resides in the presence or absence of an arch formed either by a single artery or between the constituting vessels (Bilge et al., 2006). Variations seem to be more prevalent within the complete arch category.

The formation of superficial palmar arterial arch is usually by an anastomosis between the branch of the ulnar artery (SPUA), the superficial palmar branch of the radial artery and the arteria radialis indicis. Out of the three arteries involved, SPUA

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is the most consistent providing the major supply (Standring, 2005). The variations that occur in the arch are known to be more frequent on the radial side. This may involve one or more interconnecting branches (Jelicic et al., 1988).

In view of its importance, the study of the intricate vascular pattern of SPA has continued to receive much interest following advances in microsurgical procedure for reconstructive hand surgery (Dhar and Lall, 2008). Awareness of the frequency of these arterial variations has been observed to be of great assistance in preparation and planning for safe hand surgery (Jelicic et al., 1988). Such procedures are now preceded by arterial cannulation in order to determine the exact vascular pattern and hence minimize any potential tissue damage (Dhar and Lall, 2008).

In view of this renewed interest in the vascular patterns of the hand, we have considered potentially informative to examine the patterns present in a Negro population with special attention to discovering any racial or unique variations.

Materials and Methods

A total of 134 upper limbs embalmed with formaldehyde comprising 74 right and 60 left specimens were used for the investigation. Some of the limbs were already detached and hence their sex identity could not be determined. Sex variation was therefore not considered. All the specimens were obtained from the Anatomy departments of three Medical Schools all located in the South-West region of Nigeria. Although the Medical Schools were located in a Yoruba speaking area, the tribal identity of the specimens could not be guaranteed because of the large presence of other ethnic Nigerians within the region, including non-Nigerian Africans.

The limbs were oriented in the anatomical position at embalmment of the bodies. The hands were dissected by first removing the skin covering the flexor surface of the hand with a slight extension proximal to the wrist joint and then distally in the palm to the bases of the digits. The ulnar and radial arteries identified proximal to the wrist were preserved. The palmar aponeurosis was removed together with the palmaris longus where present, to show the SPA. The SPA was more fully demonstrated by carefully removing the adipose tissue surrounding it. Branches of median and ulnar nerves were equally exposed. The different superficial arterial arch patterns observed were illustrated as well as digitally recorded with a Canon (Tokyo, Japan) D 40 professional camera. The frequency of each pattern was expressed as percentage.

Results

In this investigation on 134 upper limbs, seven patterns were identified. Four could be classified as complete arches while the remaining three were incomplete arches. The commonest complete arch (Figs. 1a, 2) was constituted by the superficial palmar branch of ulnar artery (ulnar fingers 3½) and a superficial palmar branch of radial artery that pierced the thenar muscles (radial fingers 1½). This pattern had 59.7 % prevalence (N = 80). Figs. 1b and 3 show a complete arch constituted in similar manner by the two superficial palmar arteries except that the superficial palmar branch of radial artery was superficial to the thenar muscles (radial finger 1½). This

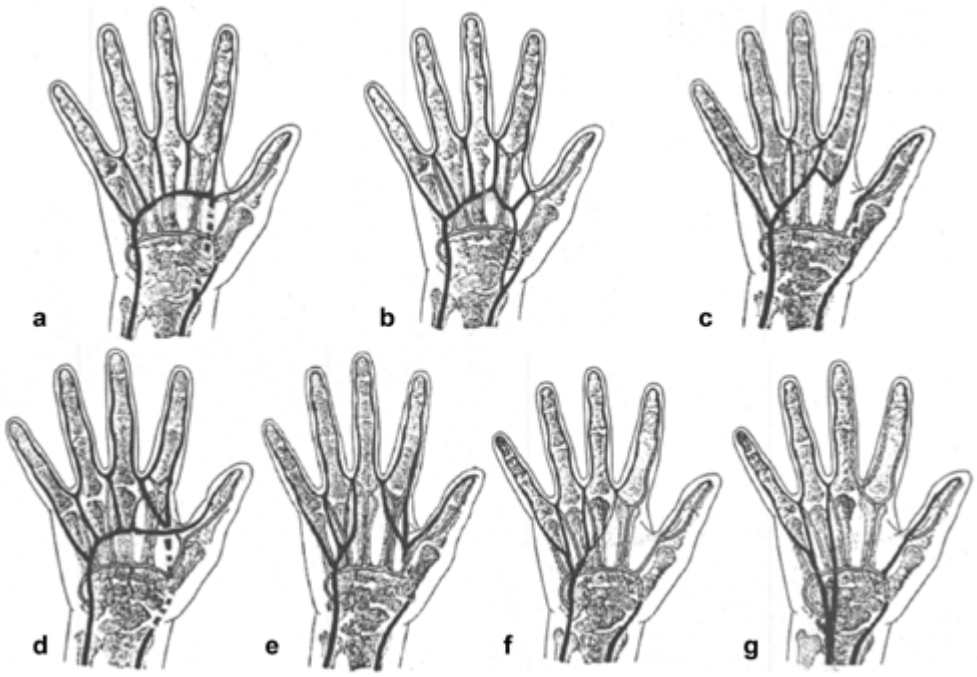

Figure 1 – Diagram of the superficial palmar arch types observed. **a**: Complete arch as depicted in Fig. 2. **b**: Complete arch as depicted in Fig. 3. **c**: Complete arch as depicted in Fig. 4. **d**: Complete arch as depicted in Fig. 5. **e**: Incomplete arch as depicted in Fig. 6. **f**: Incomplete arch as depicted in Fig. 7. **g**: Incomplete arch as depicted in Fig. 8.

Figure 2 – Complete superficial palmar arch with contribution from both ulnar and radial arteries with radial branch piercing through thenar muscles.

Figure 3 – Complete superficial palmar arch with contribution from both ulnar and radial arteries with radial branch passing across the thenar muscles.

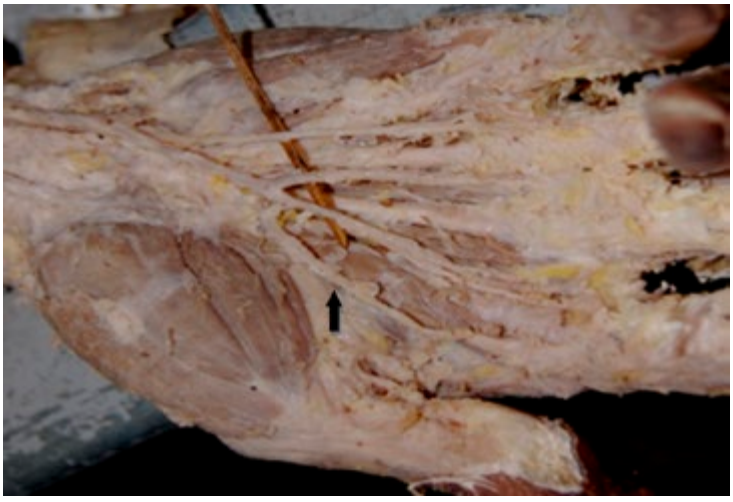

Figure 4 – Complete arch constituted entirely by ulnar artery with radial indices (arrowed black) as terminal branch.

had a prevalence of 10.4 % (N = 14). Figs. 1c and 4 show a complete arch constituted entirely by the superficial palmar branch of the ulnar artery with the radialis indicis as the terminal branch. The variation had a prevalence of 3.0 % (N = 4). Figs. 1d and 5, illustrate a complete arch formed by the superficial palmar branch of ulnar artery which gave rise to princeps pollicis artery as its terminal branch with the exclusion

Figure 5 – Complete arch formed entirely by ulnar artery having princeps pollicis (arrowed blue – dark gray in black and white print) as the terminal branch with the exclusion of radialis indicis (arrowed green – pale gray in black and white print) that arose from deep radial branch.

Figure 6 – Incomplete superficial arch in which the ulnar and radial arteries are equally dominant but with no communication.

of radialis indicis that had its origin from deep palmar branch of radial artery. This variation was observed in one case (0.8 %). Figs. 1e and 6 show an incomplete arch in which the superficial palmar branch of ulnar artery supplied the ulnar 2½ fingers while the superficial palmar branch of the radial artery supplied the radial 2½ digits with no communication between the two components. This pattern was observed in 15.7 % cases (N = 21). Figs. 1f and 7 show an incomplete arch constituted solely by

Figure 7 – Incomplete superficial arch formed solely by ulnar artery.

Figure 8 – Incomplete arterial arch formed solely by ulnar artery that veered off to the median plane.

the superficial palmar branch of ulnar artery (ulnar 3½). This was observed in 8.9 % cases (N =12). Figs. 1g and 8 show an incomplete arch formed by an ulnar artery that had veered off its course as it inclined to reach the median plane. The arch gave rise to two common palmar digital arteries that subdivided to supply two and a half digits each. The variation had a prevalence of 1.5 % (N = 2).

The laterality of each pattern (on the left or right side; Fig. 9) was also considered. Although a few of the limbs were unpaired, it was nevertheless observed that

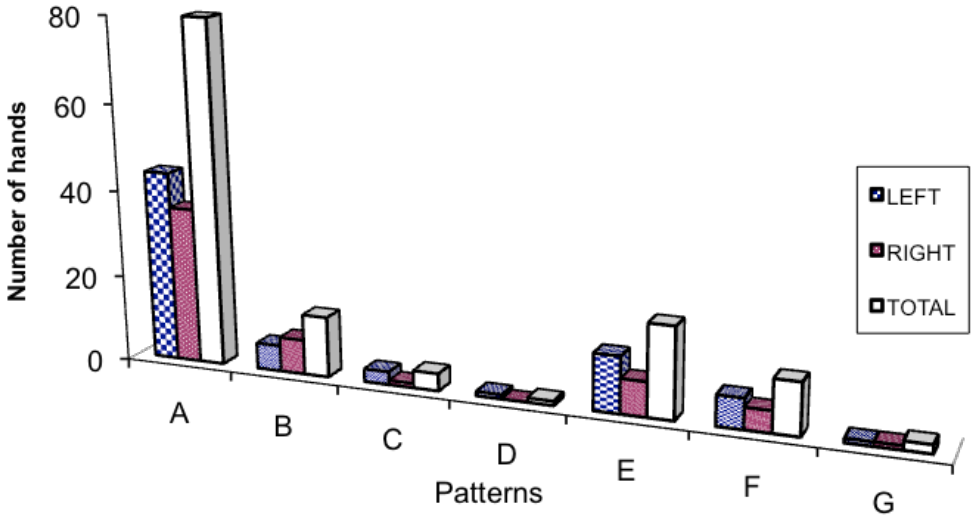

Figure 9 – Bar chart showing the frequency of the variations with complete (A-D) and incomplete arches (E-G).

the superficial palmar arterial arch pattern was strongly correlated between the right and the left side.

Discussion

The high rate of variations of the superficial palmar arch makes it an interesting area of study. A key guide to understanding the anatomy of the arterial distribution of the SPA is the classification into complete and incomplete arches based on the presence or absence of a communication between the constituting vessels or the possible formation from a single vessel. This mode of classification (Dhar and Lall, 2008) was first put forward as far back as the 18th century and has remained the best approach to understanding the various patterns of the arterial arrangement.

In this study, complete SPA formation was observed in 73.9 % of the specimens. Various reports have given a range of prevalence between 35.5 % (Moore and Dalley, 1999; Williams et al., 2000) through 78.5 % to 96.4 % (Bilge et al., 2006; Loukas et al., 2005; Coleman and Anson, 1961; Al-Turk and Metcalf, 1984). The frequency of complete arterial arch formation encountered in this study is comparable with though lower than most reported cases. However, we observed the radial component more frequently used as arterial by-pass (Joseph et al., 2005) with two types of disposition. In the first type, the superficial palmar branch of the radial artery pierced the thenar muscle before completing the SPA. This pattern was observed in 59.7 % of cases and was the classic pattern described in many anatomic texts (Rosse and Gaddum-Rosse, 1997). A variation that may not have received substantial attention on the account that it was rarer (Bataineh et al., 2009) was the superficial branch of radial artery

passing across the thenar muscles to complete the arch. In this case, the radial artery diameter was relatively large in size making it very vulnerable to hand injuries. This arterial pattern was not uncommon in the population under study, having a prevalence of 10.4 %.

In a few other cases, a complete SPA was formed exclusively by the superficial branch of the ulnar artery. In one such variation, the arch gave rise to the medial three common palmar digital arteries and terminal radialis indices. In what appeared as a complex and unique case of complete SPA that has not apparently been described before, the princeps pollicis arose from the superficial arch constituting a terminal continuation of superficial ulnar artery whereas the radialis indicis had a variant origin arising from the deep palmar branch of the radial artery as it emerged from the dorsum of the hand into the first web space. Apart from the radialis indicis branch, the deep radial artery in addition constituted the main trunk of common palmar digital artery of the second web space with a communicating branch contribution from the SPA. This arterial variation differed from the reported cases where princeps pollicis and radialis indicis arose from a common trunk from the superficial arch with no contribution from the radial artery (Vollala et al., 2009; Loukas et al., 2009). This intricate arterial pattern in which the radialis indicis and princeps pollicis arose from variant origins may be difficult to manage in traumatic situations.

Incomplete SPA exhibited considerable variation in this population. The pattern that showed the highest frequency was where ulnar and radial arteries shared an equal proportion of palmar supply with no anastomosis. In this situation, the two vessels were equally dominant component of SPA with the radial artery as the main vascular structure on the lateral half of the palm. The radial artery in this circumstance is of immense importance. Therefore, its distribution should be evaluated before it is harvested for arterial transplant.

In another variation, the arch was formed solely by the ulnar artery to ulnar 3½ of the digits. This pattern has also been illustrated in an anatomical text (McMinn, 1997). In this study, the most lateral common palmar digital artery in three cases was diminutive in size. In still another variation, the arch was formed solely by the ulnar artery which veered off it course crossing to reach the median plane. In the palm, it gave supply to ulnar 2½ of the digits. This artery might be mistaken for median artery because of its position.

There has been an increase in the use of radial artery for arterial bypass. The major risk likely to be associated with the harvest is the danger that ischaemia of soft tissues of the hand might occur (Loukas et al., 2005). The underlying factor is the frequency of variations encountered some of which are familiar while some are rare cases that may not have been described. In order to minimize the risk, the knowledge of superficial palmar arterial arrangement is crucial to ascertain which of the patterns would enable safe removal of the radial artery for use in arterial bypass surgery. More often, the lack of informed knowledge of this type of irregular pattern in hand surgery has been implicated as the underlying factor in the aetiology of palmar and digital ischaemia (Dhar and Lall, 2008).

The sound knowledge of the vascular pattern in the palm is crucial to hand surgeons engaged with reconstructive surgeries especially given the growing interest in radial artery harvest for arterial repairs and vascular grafts. In our Negro population study, deviation from normal anatomical pattern was common. Our result also high-

lighted a rare arterial arch pattern likely to pose high risk of complication if adequate precaution was not taken during vascular graft. Therefore, a review of vascular pattern prior to invasive or intervention surgery is strongly recommended, which would allow to detect anomalies likely to necessitate modification of surgical procedures.

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