Introduction: Neurovascular variations in the upper limb are common and they are well documented. They may be due to the unusual paths in the primary vascular plexuses, because of persistence of vessels which normally regress, or due to absorption of vessels which normally retains, or in the incomplete development or fusions and regressions of distinct parts. These arteries could be palmar type or medio-ulnar type. An accurate knowledge of the normal and the variant anatomy of the median artery is important for clinical procedures and for vascular surgeries. Objectives: 1) To find out incidence of persistent median artery of hand and its variations in origin and course. 2) To compare findings with previous studies and its clinical significance. Material and Methods: The present study was conducted on 40 upper limbs from 20 cadavers given for routine dissection at the Rural Medical College, Loni, Maharashtra. The whole course of the median nerve and the persistent median artery was traced from origin to its termination. Results: Out of 40 limbs dissected the persistent median artery was found in 5 limbs, in one specimen arising from anterior interosseous artery. In two specimens persistent median artery was arising from brachial artery and in other two specimens from ulnar artery. In all the specimens median artery accompanied median nerve up to wrist joint and was palmar type. Also in one case median artery pierced the median nerve. In two specimen artery forms medio-ulnar type of palmar arch while in 3 limbs it gave palmar digital branches. Conclusion: Knowledge of persistent median artery and its variations in origin and course is valuable information for surgeons dealing with hand surgeries.
The persistent median artery in the human adult has been described in two different patterns: palmar type and antebrachial type. In the palmar type a large long vessel reaches the hand; and in antebrachial types a small and short vessel, which end before reaching the wrist joint.

However an incidence of 8% of a larger persistent median artery into adult life was reported by Lippert (1885) (12). Jones (1988) (13) attributed PMA to be another aetiological factor responsible for carpal tunnel syndrome and pronator syndrome. In most of the cases, it simply accompanies the median nerve in the hand, but it may even perforate the median nerve (8, 10, 11). The later entity is however rarely seen.

The importance of the persistent median artery lies in the fact that artery with a larger caliber may lead to an early compression of the median nerve in the carpal tunnel in patients who are prone to it e.g. in myxo-oedema, rheumatoid arthritis, etc. It has also been related to the compressive pathology of the median nerve, which is secondary to arterial calcification (14), thrombosis (15) and atherosclerosis (16).

So the present study was planned to know the incidence of persistent median artery in the cadavers routinely dissected at Rural Medical College, Loni

Materials and Methods

The present study was conducted on 40 upper limbs which belonged to 20 formalized and preserved cadavers, which were obtained from the Department of Anatomy, Rural Medical College, Loni, Maharashtra. The limbs were dissected as per the dissection guidelines, given by the Cunningham’s manual of Practical Anatomy, to expose the median nerve and its whole course from its formation until its termination. Similarly, the persistent median artery was traced till its termination. The observations were photographed, variations noted at specimen preserved for future reference.

Observations

Out of 40 specimens 5 showed persistent median artery. Out of 5 specimens, persistent median artery was bilateral in 4 specimens and it was unilateral in one specimen.

In 2 specimens persistent median artery arose from trunk of ulnar artery (fig.1) along with anterior interroseous artery. After origin artery accompanied median nerve running between superficial and deep flexor muscles of forearm then passes through the carpal tunnel along with median nerve and emerged at distal border of flexor retinaculum along with median nerve (fig 2). In the same cadaver on right side it gave digital palmar branches to lateral three and half fingers i.e. thumb (princeps pollicis), index finger, middle finger and radial side of ring finger (fig 4) and on left side it gave palmar digital branches to lateral two and half fingers i.e. thumb index finger and radial half of middle finger (fig 5).

In second cadaver the bilateral persistent median artery was found arising directly from brachial artery (fig 3) before it divides into radial and ulnar artery in cubital fossa and travel along with median nerve having the same course between superficial and deep flexor muscles up to the flexor retinaculum. After passing through carpal tunnel emerges at the distal border of flexor retinaculum and contributes in the formation of superficial palmar arch with ulnar artery and gives palmar digital branches to thumb and index finger.

In third cadaver unilateral variation was noted and found only in right hand. The persistent median artery arose from anterior interroseous artery and pierces the median nerve (fig 6) dividing it in to two branches that join again to form a single nerve. The artery then traveled along with the median nerve up to the distal border of flexor retinaculum. Then entered in the formation of superficial palmar arch with ulnar artery and gives palmar digital branches supplying thumb and ulnar aspect of index finger and radial aspect of middle finger. The radial aspect of index finger was supplied by deep branch of radial artery (arteria radialis indicis) (fig 7).

In all the specimens studied anastomosis with superficial palmar branch of radial artery was not seen. In all cases the early bifurcation of median nerve was found i.e. before entering the carpal tunnel (fig 8), the first branch continued as the first common digital nerve and second branch gave of the second and third common digital nerves.

Legends for the figures

Fig. 1 persistent median artery originating from trunk of ulnar artery

1) Brachial artery 2) radial artery 3) median artery 4) anterior interroseous artery 5) ulnar artery

Fig 2 Persistent median artery entering palm

1) Ulnar nerve 2) median nerve 3) median artery 4) ulnar artery 5) flexor retinaculum

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Fig 3 persistent median artery originating from brachial artery
1) Brachial artery 2) median artery 3) radial artery 4) ulnar artery

Fig 4 medio-ulnar type of superficial palmar arch (right hand)
1) Median artery 2) ulnar artery 3) radial artery 4) medio-ulnar type of SPA 5) palmar digital branches

Fig 5 Medio-ulnar type of superficial palmar arch (left hand)
1) Medio-ulnar type of palmar arch 2) palmar digital branches 3) median artery 4) ulnar artery 5) radial artery

Fig 6 Median artery originating from anterior interosseous artery and piercing the median nerve
1) Median nerve 2) ulnar artery 3) bifurcation of median nerve 4) median artery 5) anterior interosseous artery

Discussion
The median artery of the forearm is persistent part of axis artery of forearm. Persistence of a median artery is not uncommon. The reported incidence ranges from 2.2-4.4 % (1). Lindley et al. reported an incidence of 3.4% in 526 carpal tunnel cases (12). Lippert and Pabst reported this incidence as 8 % (13), whereas Henneberg and George reported an incidence of 27.1 % in Southern African cadavers (5). In our study we observed 12.5% incidence of persistent median artery. The wide variations reported in incidence of PMA in different studies may be because of racial and ethnic differences in the study population.
The median artery persists into adulthood in two forms. Rodriguez-Niedenfuhr et al (17) described two different patterns of the persistent median artery, based on their vascular territories: the palmar and antebrachial types. The first, an antebrachial type, is considered normal, arises mostly from the anterior interosseous artery, and does not reach the palm. The second, a palmar type, may arise from any of the arteries of forearm and accompanies the median nerve in the carpal tunnel. It usually terminates as the superficial arch or as the main blood supplier to the index and long fingers (7). The term PMA refers to the palmar type of the median artery (4).

The persistent median arteries we encountered were of palmar type. In three hands it was contributing in the formation of superficial palmar arch i.e. medio-ulnar type of arch (arch formed from anastomosis between the ulnar and median arteries).

While in two cases the artery entered deep to flexor retinaculum & had given the digital branches. The superficial palmar arch was incomplete (3) in two specimens.

Eid (2011) reported two cases of unilateral PMA with variation in the level of the origin of the median artery which persisted into the adult life (13). George (1996) reported a 50% incidence of PMA in his study of 60 South African neonates (8).

In our study in one cadaver we saw the median artery arose from the ulnar artery directly and gave palmar digital branches supplying thumb and second and third inter digital spaces on right side while in left limb the artery arose from ulnar artery and gave branches to thumb and second inter-digital space. Tsuruo et al (16) had also described similar origin and gave branches to the ulnar side of the thumb and second inter-digital space.

This type of origin is not the most frequent type, but it is well documented in the literature Khashaba, Balakrishnan et al., Barfred et al (17), Rose, Jackson and Campbell, and Lisanti et al have all reported carpal tunnel syndrome caused by a thrombosed persistent median artery.

Tsuruo et al reported an incomplete, mediano-ulnar type of the superficial palmar arch.

In a case report, Ramanathan et al (18), observed the superficial arterial system, which was associated with a palmar type of the median artery in the left limb of a 52-year-old cadaver.

There are reports of division of median nerve by median artery & some authors have reported unusually high division of median nerve (Kornberg et al 1983 (19), J.R.Sanudo et al1994). J. R. Sanudo et al 1994 described presence of both these variations in the same limb. A conjuncture of a split median nerve with the persistence of a median artery has been reported in the literature (20, 21, 22).

The PMA can also perforate the median nerve just proximal to the origin of the anterior interosseous nerve, below the pronator teres muscle, dividing it into two branches that join again to form a single nerve (14, 16). Rodriguez-Niedenfuhr et al. (15) found that the PMA pierced the median nerve in 41% of the cases studied.

Clinical Significance

A PMA has been discussed as a possible cause for carpal tunnel syndrome in series in several reports in the surgical literature (14, 15, 16). An anomalous artery which penetrates the median nerve in the arm can compress it and produce symptoms of proximal median neuropathy which is similar to the Struthers ligament or a tight bicapitalapneuorsis. The compressive force of the penetrated pulsating artery may produce ischemia which is distributed unequally in the nerve, damaging those fibres which are destined to become one branch of the median nerve. These nerves are usually weak at the site of the arterial penetration and they are more susceptible to pathological conditions such as diabetes mellitus (21).

Furthermore, a persistent median artery may compensate the blood supply to hand in radial or ulnar artery injuries, or it may be used as a graft elsewhere in the body, if present (6). When it is much enlarged and thrombosed it may compress the median nerve and cause symptoms of carpal tunnel Syndrome (5, 6, 10, 11). Barfred et al have reported carpal tunnel syndrome caused by a thrombosed persistent median artery. The superficial course of the persistent median artery close to the flexor retinaculum may damage the blood supply of the hand during excision.

In the absence of thrombosis, median artery excision is unnecessary (9).

Conclusion

As the incidence of persistent median artery is varied, knowledge about its incidence in different population is important to know the racial effect. The palmar type of median arteries appear to be a predisposing factor in carpal tunnel syndrome and in pronator teres syndrome so it is important to know the presence of persistent median artery its course and origin in routine clinical practice before undertaking any surgical procedure. The knowledge of PMA will be an added advantage for radiologist; cardiothoracic surgeons harvesting the artery for a coronary graft provided these variations are diagnosed in each patient prior to the procedure as a routine. Existence of arterial variations of the hand though common, knowledge of their existence would help to determine the approaches by reconstructive Plastic and vascular surgeons of the hand.

Because of time and resource constraint our sample size was small so there is need of further exploratory studies pertaining to the PMA with larger sample size.

REFERENCES

