[Case Report] High Bifurcation and Anatomical Variation of The Brachial Artery

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Abstract

Background: The brachial artery provides the main arterial supply to the arm and is the continuation of the axillary artery. It is critical that potential morphological and structural variations be taken into consideration in everyday surgical practice as a lack of awareness could lead to fatal consequences. The major variations in the arterial patterns reported are the higher origin of radial and ulnar arteries.

Case report: During dissection of right part of the upper limb, I found brachial artery as it courses with the median nerve which was crossing posterior surface of the brachial artery in the arm. The brachial artery was found bifurcating at middle third of the arm, into radial artery and the ulnar artery. When pharyngeal arches form during the fourth and fifth weeks of development, each arch receives its own artery. These arteries, the aortic arches, arise from the aortic sac, the most distal part of the truncus arteriosus.

Conclusion: Implication of this anatomical variation is very important to conduct clinical procedures particularly, orthopaedic, plastic and vascular surgeries.

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1. Background

The brachial artery provides the main arterial supply to the arm and is the continuation of the axillary artery. It begins at the inferior border of the teres major, and ends in the cubital fossa opposite the neck of the radius where, under cover of the bicipital aponeurosis, it divides into the radial and ulnar arteries. The brachial artery, relatively superficial and palpable throughout its course, lies anterior to the triceps and brachialis. At first it lies medial to the humerus where its pulsations are palpable in the medial bicipital groove. It then passes anterior to the medial supra-epicondylar ridge and trochlea of the humerus. As it passes inferolaterally, the brachial artery accompanies the median nerve, which crosses anterior to the artery. During its course through the arm, the brachial artery gives rise to many unnamed muscular branches, and the humeral nutrient artery, which arise from its lateral aspect. The main named branches of the brachial artery arising from its medial aspect are the profunda brachii artery (deep artery of the arm) and the superior and inferior ulnar collateral arteries [1].

It is critical that potential morphological and structural variations be taken into consideration in everyday surgical practice as a lack of awareness could lead to fatal consequences. Moreover, an intimate knowledge of arterial anatomy of upper extremities and its common variations is indispensable to limb surgeons. Appreciation of variations in the upper extremity vasculature is essential to prevent injury, thrombosis, gangrene and even amputation of limbs, particularly in patients requiring dialysis or undergoing arteriography. Accurate knowledge of course and relations to surrounding structures is of great importance for surgeon, radiologists, anatomists and routine patient as well [2].

The major variations in the arterial patterns reported are the higher origin of radial and ulnar arteries[3]. Sometimes the brachial artery divides at a more proximal level than usual. In this case, the ulnar and radial arteries begin in the superior or middle part of the arm, and the median nerve passes between them. The musculocutaneous and median nerves commonly communicate between them [1]. In this case report, variations of the brachial artery, compared with a pattern reported previously.

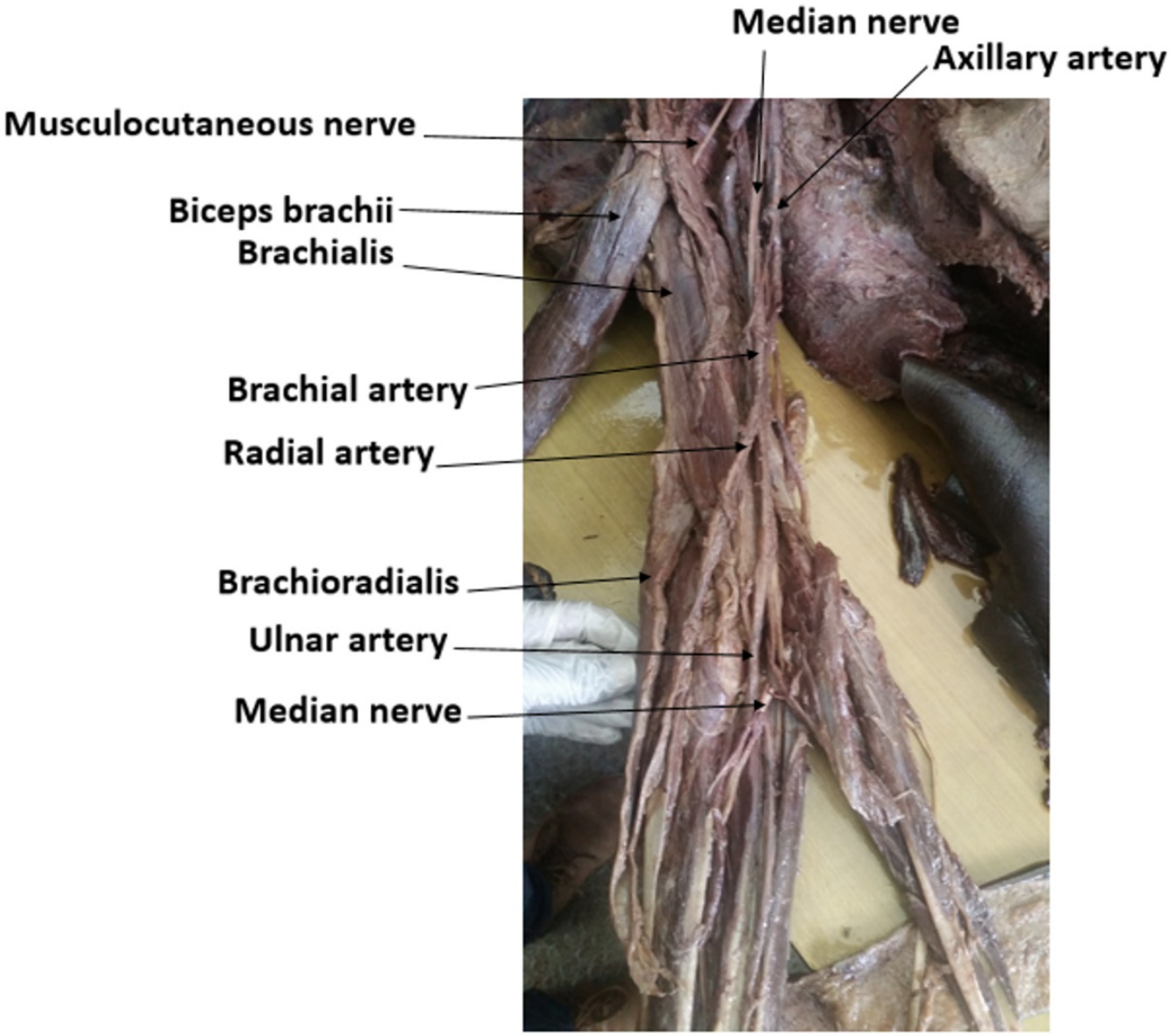

Figure 1. Radial artery arising at a higher level in the right arm.

2. Case report

During a routine dissection of the upper limb in the Anatomy laboratory, at the department of medicine for pre-clinical-I students, at Wachemo University, an unusual arterial variation was observed in a 65-year-old male cadaver preserved in formaldehyde solution. The dissection was started with skin incision of the anterior compartment of arm and using blunt dissection with a probe we demonstrated the superficial veins of the arm. Then muscle in the anterior arm was separated to dissect deep structure in the arm and axilla. We used scissors to open the anterior surface of the axillary sheath and identified the axillary vein which was formed by the joining of the two brachial veins. To enhance dissection of the arteries and nerves in the axilla, the axillary veins with its tributaries was removed. The axillary artery was surrounded by the brachial plexus. The brachial plexus was then retracted and preserved during dissection of the axillary artery and its branches. While dissecting axilla we found the musculocutaneous nerve as it enters the coracobrachialis muscle (figure

1).

During dissection of right part of the upper limb, we found brachial artery as it courses with the median nerve which was crossing posterior surface of the brachial artery in the arm. The brachial artery was found bifurcating at middle third of the arm, into radial artery and the ulnar artery (figure 1). Radial artery crossing superficial surface of the brachialis muscle in the arm and crossing cubital fossa to enter deep surface of brachioradialis muscle in the forearm. The brachial artery continued as ulnar artery in the forearm. Branching patterns of the radial and ulnar arteries in the forearm and hand were usual. The left arm showed no unusual vascular observations.

3. Discussion

Blood vessel development occurs by two mechanisms:[1] vasculogenesis in which vessels arise by coalescence of angioblasts and [2] angiogenesis whereby vessels sprout from existing vessels. The major vessels, including the dorsal aorta and cardinal veins, are formed by vasculogenesis. The remainder of the vascular system then forms by angiogenesis. The entire system is patterned by guidance cues involving vascular endothelial growth factor (VEGF) and other growth factors (figure 2). When pharyngeal arches form during the fourth and fifth weeks of development, each arch receives its own artery. These arteries, the aortic arches, arise from the aortic sac, the most distal part of the truncus arteriosus [4].

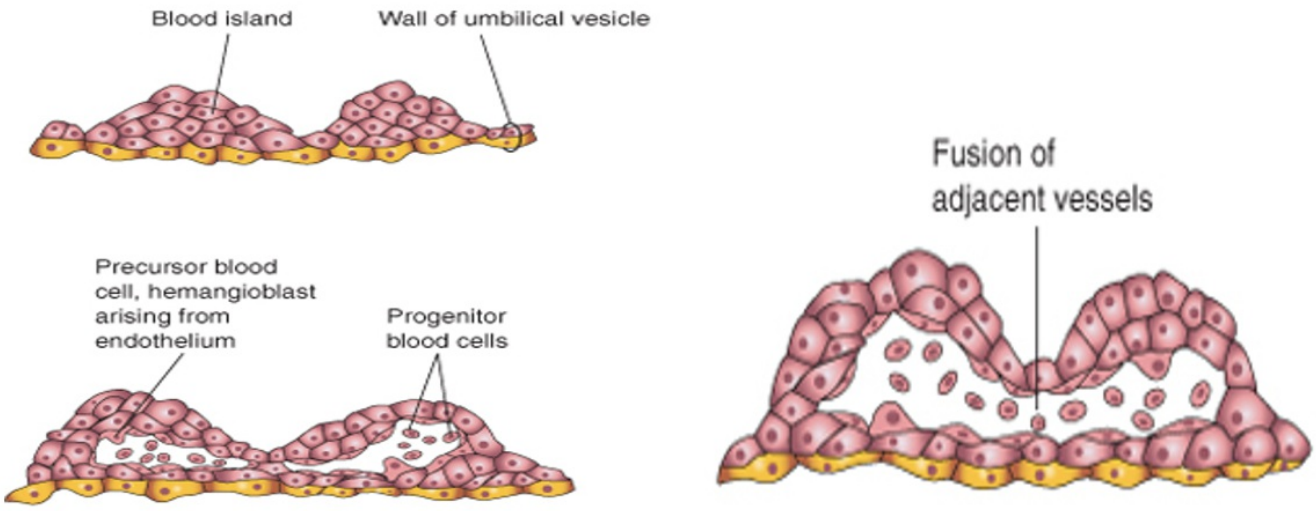

Figure 2. Successive stages in the development of blood and blood vessels [4]

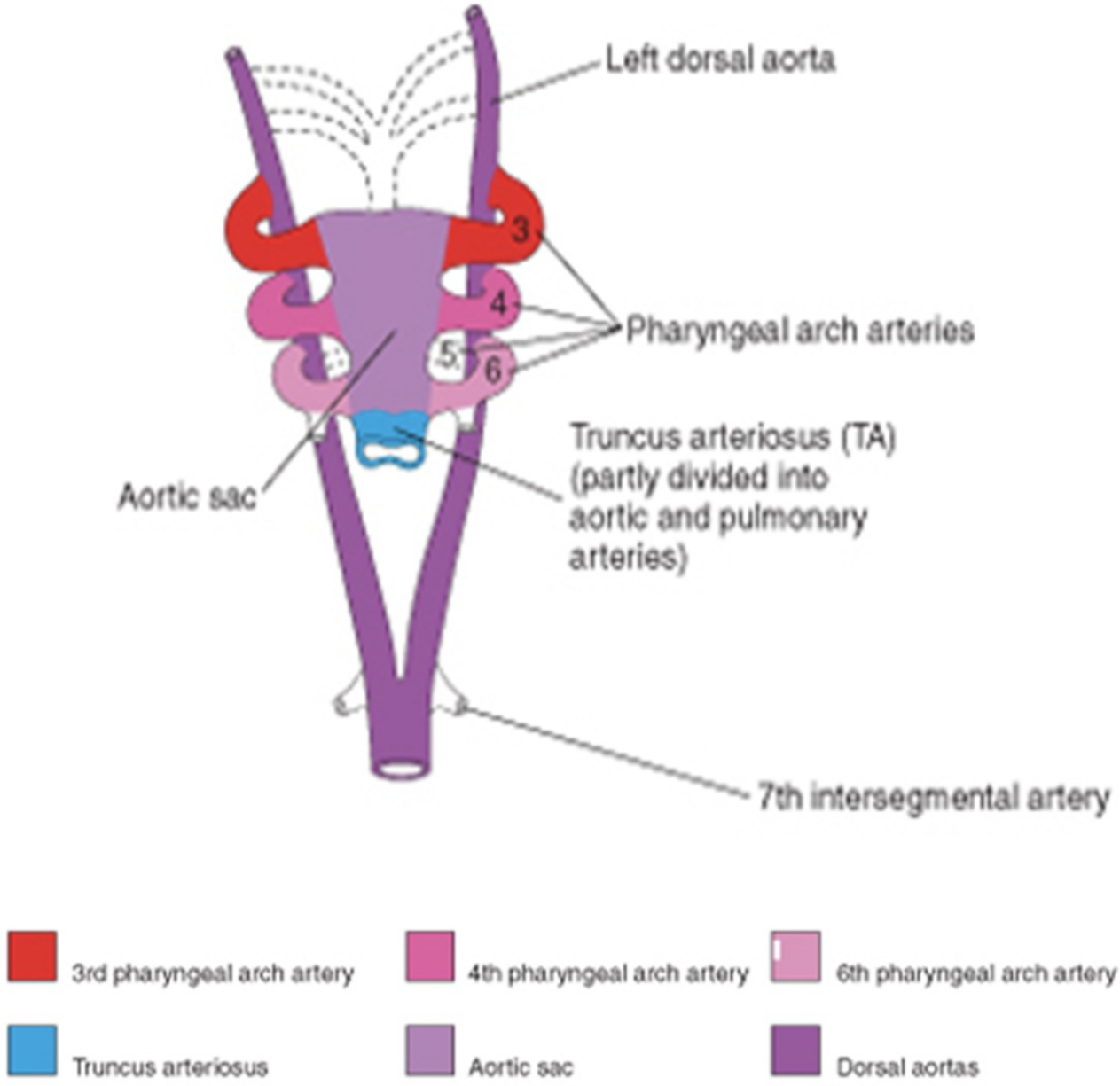

Figure 3. Pharyngeal arch artery [4]

3.1. Embryonic differentiation of the upper limb vessels

In the upper limb bud, the axis artery is derived from the lateral branch of the seventh intersegmental artery that is subclavian artery. The proximal part of the main trunk of this artery forms axillary and brachial arteries and its distal part persists as anterior interosseous artery and deep palmer arch. Radial and ulnar arteries are last to appear in the forearm from the axis artery, that is brachial artery. Initially, the radial artery arises more proximally than the ulnar artery. Later, it establishes a new connection with the main trunk at or near the level of the ulnar artery. The upper portion of its original stem usually disappears to a large extent. Persistence of the upper portion of the radial artery arising from the brachial artery proximal to origin of the ulnar artery followed by failure of development of the new connection of the radial artery

with the brachial artery at the level of origin of the ulnar artery causes this type of anomaly [5][6].

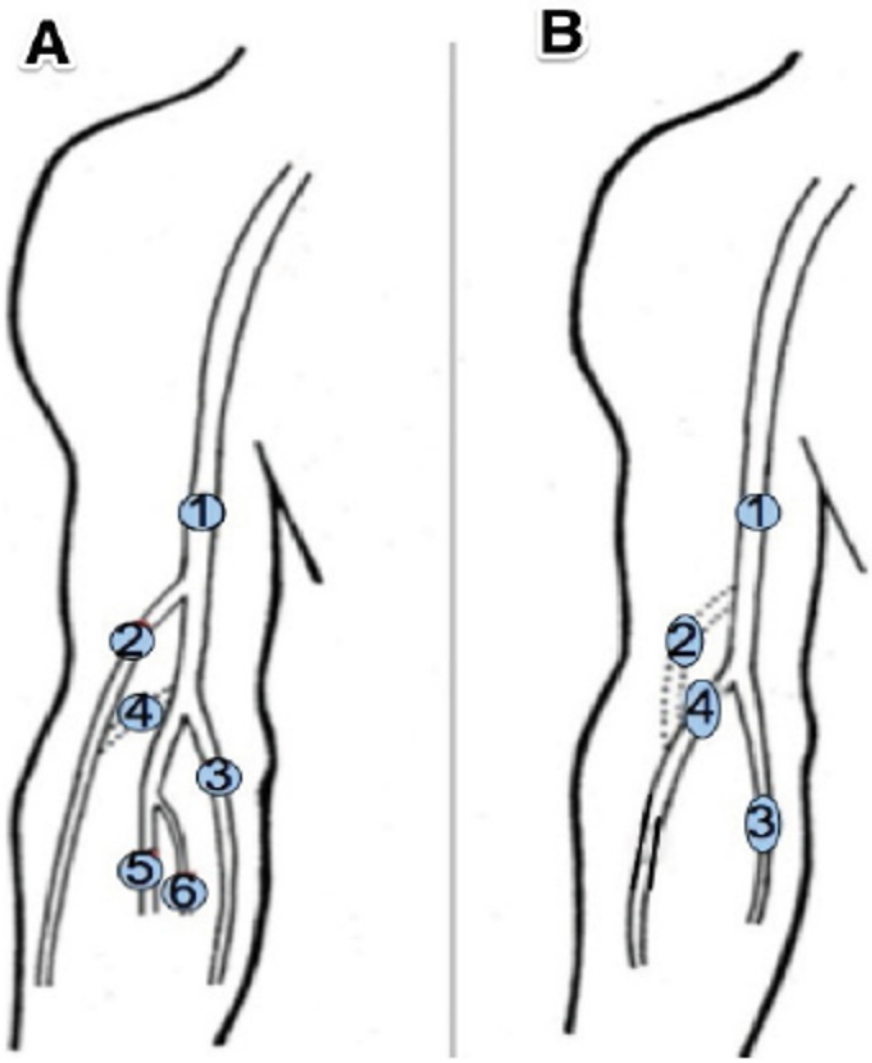

Figure 4. Schematic diagram of development of brachial artery showing the normal pattern (B) and variant as seen in our case (A). 1, brachial artery; 2, radial artery—initial connection; 3, ulnar artery; 4, radial artery—final connection; 5, anterior interosseous artery and 6, median artery [6].

3.2. Clinical significance of the brachial artery

From a clinical point of view, the BA plays an important role in the measurement of blood pressure: the stethoscope is placed in the region of the cubital fossa during auscultatory blood pressure measurement. This is directly due to the superficial location of the artery in relation to the skin. The BA also plays a role in oscillometric pressure measurement: the blood pressure cuff is placed at the distal and medial part of the arm around the space between the biceps brachii muscle and triceps brachii muscle [7].

The cubital anastomosis or the peri-articular arterial anastomoses of the elbow is an anatomical structure in the nature of vessels. This network is supplied with arterial blood from the superior and inferior ulnar collateral arteries, branches from

the deep brachial artery, branches from the radial recurrent artery and branches from the ulnar recurrent artery [1]. The cubital anastomosis of the elbow is responsible for supplying the elbow joint and its supporting structures. A network of arterial vessels allows oxygenated blood to circulate around the elbow joint no matter which position the joint is in. It provides proper nutrition to the structures of the ligaments and joint capsule minimalizing the risk of insufficient vascularization [7].

Supracondylar fractures of the humerus are commonly observed in children. It has been documented that approximately 12% of completely displaced supracondylar fractures in the pediatric population result in vascular injuries, with the brachial artery being predominantly affected. Notable vascular complications associated with this injury include brachial artery occlusion and the potential risk of limb loss. Additionally, limb claudication may occur as another vascular complication, which can result from either the migration of a thrombus leading to restricted blood flow or inadequate repair of the brachial artery [8][9].

3.3. Prevalence of variations of high bifurcation of the brachial artery

Similar case reports with my finding (high bifurcation of the brachial artery) were reported by various authors[10]. Rodríguez-Niedenführ *et al.* propose the term “brachioradial artery” for the high origin radial artery. On its course, the brachioradial artery crosses the musculocutaneous nerve and adopts an anterior, superficial position to it along the arm. In the region of the antecubital fossa, the brachioradial artery passes posterior to the bicipital aponeurosis more often than anterior to it [11]. In studies conducted by Nasr[12], the brachioradial artery was observed in 8 out of 100 upper extremities (8% of all cases) from 30 adult male cadavers and 20 female cadavers. In seven cases, the source of RA was a brachial artery; the radial artery took its course from the axillary artery in only one case. The high origin of radial artery was observed in five right and three left upper extremities [12]. Haładaj *et al.* [10] also undertook brachioradial artery research. In the dissection of 120 upper extremities (65 male and 55 female limbs), the presence of a high origin of brachial artery was found in 11 cases (9.2%) [10]. This variation was noticed in five female limbs and six male limbs, while the brachioradial artery arose from the brachial artery in five female and four male upper limbs. In two remaining cases (both in male right limbs) the brachioradial artery branched off from the axillary artery. Among 11 specimens, no significant difference was found with regard to the side: the brachial artery occurred in six cases on the right side and in five cases on the left side. The abnormal high origin of radial artery was not predominant on the right or the left side [10].

	Number of examined limbs	Number of brachoradial arteries	On the right	On the left	Origin from the BA	Origin from the AA
Nasr	100	8	5	3	7	1
Haładaj et al.	120	11	6	5	9	2
Rodríguez-Niedenführ et al.	384	53	30	23	40	12

Table 1. Cases of variation of brachial artery (brachioradial arteries) according to Nasr [12], Haładaj et al. [10] and Rodríguez Niedenführ et al. [11].

4. Conclusion

Implication of this anatomical variation is that its influence especially on the conduct of clinical or surgical procedures, like arteriography images and could have serious implications in orthopaedic, plastic and vascular surgeries. Additionally, its effect on the blood pressure measurement, which is normally measured in the arm in the brachial artery.

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