

Hemodynamic Implications of Bifurcated Femoral Arteries in Peripheral Arterial Disease

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DESCRIPTION

The femoral artery is a major vessel in the lower limb, supplying oxygenated blood to the thigh, leg and foot. Its anatomical variations, particularly bifurcations, hold significant clinical and surgical implications. While the standard femoral artery continues as a single trunk before giving rise to its branches, bifurcation patterns may occur at varying levels, altering the vessel's course and branching structure. Understanding these variations is important for clinicians, interventional radiologists and vascular surgeons, as they directly affect the safety and effectiveness of diagnostic procedures, surgical interventions and endovascular therapies.

Anatomical studies have shown that bifurcation of the femoral artery can occur at different levels: within the inguinal region, immediately below the inguinal ligament, or further distally along the femoral course. The bifurcation typically involves the division into the Superficial Femoral Artery (SFA) and Deep Femoral Artery (DFA), but variations may include accessory branches, early divisions, or unusual trajectories. Such deviations can be congenital or develop due to compensatory remodeling in response to altered hemodynamics. Morphometric analysis of bifurcated femoral arteries, using cadaveric dissections and imaging modalities such as Computed Tomography (CT) angiography and Doppler ultrasonography, provides detailed insights into vessel diameter, length and branching angles. These parameters are essential for planning surgical or interventional approaches and for minimizing intraoperative complications.

Clinically, the presence of a bifurcated femoral artery is of particular importance in vascular access procedures. Catheterization, angiography and stent placement often rely on accurate identification of the femoral artery and its branches. Misidentification of the bifurcation point can lead to arterial injury, hematoma formation, or inadvertent puncture of the deep femoral artery, which may be more prone to bleeding due to its deeper anatomical location. In addition, the bifurcation pattern affects the distribution of collateral blood flow in cases of arterial occlusion or peripheral arterial disease.

Understanding the specific anatomy in individual patients helps optimize endovascular strategies and improves the success rate of procedures such as angioplasty, thrombectomy and bypass grafting.

From a surgical perspective, bifurcated femoral arteries require careful preoperative assessment. Procedures such as femoral artery bypass, grafting, or endarterectomy demand precise knowledge of branch locations to ensure adequate perfusion and avoid ischemic complications. In trauma cases, where the femoral artery may be injured due to penetrating or blunt injuries, the presence of an atypical bifurcation can complicate hemostasis and vessel repair. Surgeons must be aware of potential variations to select the most suitable approach, whether it involves open surgery or minimally invasive endovascular repair.

Bifurcated femoral arteries also have implications in diagnostic imaging and disease management. Doppler ultrasonography is often the first-line tool for assessing arterial flow and detecting stenosis or aneurysms, but variations in bifurcation may lead to misinterpretation if the examiner is unaware of anatomical differences. Similarly, CT angiography and MR angiography provide high-resolution images that can reveal subtle deviations in vessel course and branching, aiding in the planning of interventions. Accurate imaging allows clinicians to evaluate vessel patency, measure diameters for stent sizing and assess collateral circulation, which is critical in patients with peripheral artery disease or diabetic vascular complications.

Moreover, the study of bifurcated femoral arteries contributes to the understanding of hemodynamic stress and its role in vascular pathology. Computational fluid dynamics simulations indicate that areas near bifurcation points experience altered flow velocity and wall shear stress, which may predispose the vessel to atherosclerotic plaque formation, thrombus development, or aneurysmal dilation. Such insights highlight the importance of integrating anatomical, clinical and hemodynamic analyses when evaluating patients for vascular interventions.

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CONCLUSION

In conclusion, bifurcated femoral arteries represent a significant anatomical variation with profound clinical, surgical and diagnostic implications. Detailed morphometric analysis, imaging evaluation and awareness of possible deviations are essential for minimizing complications in catheterization, surgery and trauma management. Furthermore, understanding the hemodynamic consequences of bifurcation enhances the

ability to predict sites prone to vascular disease. As imaging technologies and computational modeling advance, clinicians can increasingly tailor interventions to individual vascular anatomy, improving patient outcomes and reducing the risks associated with femoral artery procedures. Recognition and careful analysis of femoral artery bifurcation are therefore integral to modern vascular medicine, highlighting the intersection of anatomy, clinical practice and patient safety.