Variations of the Circumflex Fibular Artery and its Implications in Proximal Fibular Epiphyseal Transfers

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Introduction

The circumflex fibular artery is described in anatomy textbooks as branching from the posterior tibial artery, or alternatively, from the anterior tibial artery, and even less frequently, from the popliteal artery[1,2]. The purpose of our study was to examine the variation incidence of the circumflex fibular artery branching pattern due to a current lack of studies in this area.

The origin of this artery is of clinical importance to determine whether a proximal fibular epiphyseal transfer may be performed. This difficult and challenging procedure is considered in pediatric patients who have experienced traumatic injury to their distal fibular growth plate. With damage to the growth plate, there is significant risk for severe ankle joint instability and valgus deformity, which can severely impact daily function. By having an increased understanding of the circumflex fibular artery's variations, the ability to perform and development of proper technique for proximal fibular epiphyseal transfers can be determined.

Methodology

Our cadaveric study explored one hundred lower extremities over a seven year time frame from the Lower Limb Anatomy course at Des Moines University. Circumflex fibular arteries were identified via direct observation by the authors. Vessels were only included in the study if a definitive artery could be identified coursing through the soleus muscle or if it had been teased from the soleus and was circumnavigating the fibular neck. Anterior and posterior courses of the artery were not taken into consideration.

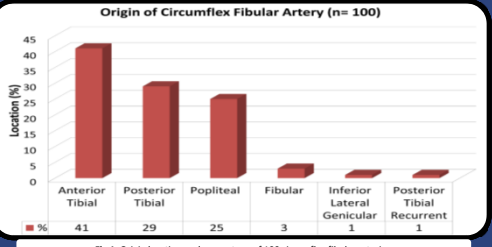

Fig 1. Origin location and percentage of 100 circumflex fibular arteries.

Discussion

Our results differ from current available anatomy textbooks, which state the origin of the circumflex fibular artery arises most often from the posterior tibial artery with variable contributions from the anterior tibial artery and popliteal artery. Data collection over the last seven years demonstrates that the anterior tibial artery is the major contributor to the origin of the circumflex fibular artery. Vascularized fibular epiphyseal transfer utilizing the circumflex fibular artery from the anterior tibial artery allows reconstruction of long bone epiphyseal defects while conserving growth potentials in children due to an active growth plate.

A review of the literature illustrates several successful cases of proximal fibular epiphyseal transfers where all discussed blood flow to the bone graft. In 2012, Medrykowski[3] published a case study demonstrating the versatility of the proximal fibular epiphyseal transfer. The procedure was used to treat a resection of a Ewing's sarcoma in the proximal humerus, as well as a traumatic distal radial amputation.

Bibbo et al[4], cites Innocenti's study[6] demonstrating 100% healing of graft-host junction and 85% continued growth at the physis site resulting in significant functional benefit facilitating longitudinal growth and joint stability. Further discussion stated that nonvascularized fibular grafts for lateral malleolar reconstruction is not optimum. This was also mentioned by other authors who reported unpredictable or diminished-to-absent growth results with non-vascularized transfers[5].

Innocenti et al[6], stated that the anterior tibial artery provides a more constant and reliable blood supply to the fibular head and growth plate compared to other vessels. When a transfer is performed in a child where epiphyseal growth is necessary, the graft must be vascularized by the anterior tibial artery.

Mozaffarian et al[7], determined that an epiphyseal graft vascularized by the anterior tibial artery alone could be extended 12.9 cm along the shaft. They also found anatomic variations in the circumflex fibular artery making preoperative angiography a prerequisite to determine the origin of the circumflex fibular artery. This is vital as origin from other than the anterior tibial artery would contraindicate fibular epiphyseal grafting due to deficient pedicle length.

Finally, Gauzy[8] published a case report with 2.5 years follow-up from a proximal epiphyseal transfer. The 13 year-old male declined an ankle arthrodesis, which limits ankle motion and can create leg length discrepancy. On follow-up, the patient was pain free, walking without a limp, could run and jump, and was playing competitive football.

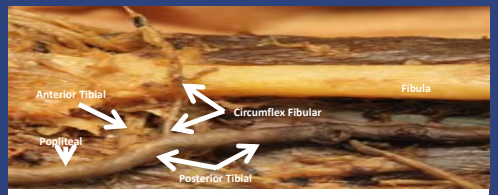

Fig. 3. Variation demonstrating the circumflex fibular artery originating from the posterior tibial artery. Typical origin according to textbooks.

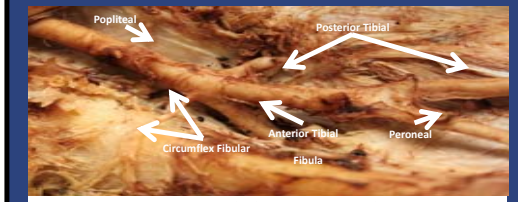

Fig. 2. Variation demonstrating the circumflex fibular artery originating from the popliteal artery.

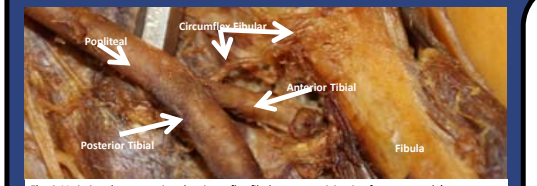

Fig. 4. Variation demonstrating the circumflex fibular artery originating from our study's most common origin, the anterior tibial artery.

Results

Our study revealed the most common origin of the circumflex fibular artery to be from the anterior tibial artery in 41% of specimens. It branched from the posterior tibial and popliteal arteries in 29% and 25% of cases, respectively. Additionally, three outliers found are as follows: in 3% of the limbs, the fibular artery gave rise to the circumflex fibular artery, while the inferior lateral genicular and posterior tibial recurrent arteries, supplied the branch 1% each.

Conclusion

Injury of pediatric physeal complexes can lead to necrosis of growth plates and deformity. A proximal fibular epiphyseal transfer is a reconstructive option for correction when longitudinal growth and stability in the distal fibular physeal plate is compromised. This procedure is warranted only when the circumflex fibular artery originates from the anterior tibial artery, as it allows for a larger bone and vascular transfer[4]. Our cadaveric research demonstrates that the anterior tibial artery is the origin 41% of the time, compared to 29% posterior tibial artery and 25% popliteal artery. Although our study contradicts current Academia texts, our findings support the use of proximal fibular epiphyseal transfers pending origin determination via angiography.

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