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Evaluation of Normal Distal Tibiofibular Syndesmosis with Postmortem Computed Tomography (PMCT)

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Introduction

The tibiofibular syndesmosis is a fibrous joint located at the distal ends of the tibia and fibula. It plays an essential role in maintaining the stability and proper alignment of the ankle and foot. The syndesmosis is held together by a complex network of ligaments, including the Anterior Tibiofibular Ligament (ATFL), the Posterior Tibiofibular Ligament (PTFL) and the interosseous membrane. These structures contribute to the overall functionality of the ankle joint, including shock absorption, load transfer and the prevention of excessive separation of the tibia and fibula. In cases of trauma, such as ankle fractures or high-energy injuries, the integrity of the tibiofibular syndesmosis can be compromised. Understanding the normal anatomy and the potential variations in the syndesmosis is crucial for diagnosing and managing injuries in this region. Traditional imaging modalities, such as X-rays, MRI and CT scans, have been employed for evaluation. However, with the advent of Postmortem Computed Tomography (PMCT), a novel and increasingly important technique for examining skeletal structures in forensic and clinical settings, there has been a shift in the ability to assess the normal morphology of the distal tibiofibular syndesmosis [1].

Postmortem CT (PMCT) offers several advantages over conventional methods. It is non-invasive, provides high-resolution three-dimensional imaging and allows for detailed visualization of the anatomy without the need for dissection or potentially destructive methods. While PMCT has been traditionally utilized in forensic pathology to investigate causes of death, its application in orthopedic research, especially in evaluating skeletal structures like the distal tibiofibular syndesmosis, is gaining traction. By examining the anatomical features, technical considerations and potential applications of PMCT, this paper will provide a comprehensive overview of how this imaging modality can be utilized to better understand the structure and function of the distal tibiofibular syndesmosis [2].

Description

The distal tibiofibular syndesmosis is a critical structure in the lower limb, connecting the distal ends of the tibia and fibula. The tibia, the larger and weight-bearing bone of the leg and the fibula, a smaller bone running parallel to the tibia, are linked by several ligaments at their distal ends. These ligaments are essential for maintaining stability at the ankle joint. Anterior Tibiofibular Ligament (ATFL) ligament connects the anterior surfaces of the tibia and fibula. It is often considered the primary ligamentous structure of the syndesmosis and plays a key role in preventing excessive separation of the two bones. It is relatively strong, though susceptible to injury in certain ankle fractures or dislocations. Posterior Tibiofibular Ligament (PTFL) is Located posteriorly, this ligament provides additional stability to the syndesmosis, preventing the fibula from moving too far away from the tibia. Interosseous membrane are fibrous structure connects the tibia and fibula along their entire length, but it is particularly important in the region near the ankle. The interosseous membrane helps to distribute forces and stabilize the fibula relative to the tibia, particularly during weight-bearing activities. Distal Tibiofibular Joint (DTFJ) is not a true synovial joint but rather a syndesmosis, meaning it is a fibrous joint held together by ligaments and connective tissue. The slight mobility it allows is essential for the proper functioning of the ankle joint, especially during dorsiflexion and plantarflexion of the foot [3].

The normal anatomy of the distal tibiofibular syndesmosis must be maintained for proper function. Any disruption in the continuity of the ligaments or abnormal alignment of the tibia and fibula can lead to instability, pain and impaired function of the ankle. While the general anatomy of the distal tibiofibular syndesmosis is well-defined, there can be variations in its size, shape and orientation. Tibiofibular Distance (TFD) is the distance between the tibia and fibula at the syndesmosis can vary. It is typically small, but some variation is normal based on age, sex and the presence of other anatomical factors such as the presence of a fibrous gap or interosseous membrane thickness. The orientation of the tibia and fibula can also vary. While in most individuals, the fibula lies slightly posterior and distal to the tibia, this alignment can differ slightly due to anatomical variations or postural differences. There can be variations in the size and robustness of the ligaments surrounding the syndesmosis, with some individuals having stronger or more pronounced ligaments than others. These variations may impact the overall stability of the syndesmosis and the likelihood of injury under stress. The evaluation of these normal variations is essential in understanding the range of normal anatomical differences in the syndesmosis, which can be useful in identifying pathology in cases of injury or disease [4].

Postmortem Computed Tomography (PMCT) offers several advantages over traditional methods when it comes to imaging the tibiofibular syndesmosis. PMCT is particularly effective in providing high-resolution, three-dimensional reconstructions of skeletal anatomy, making it possible to assess the exact morphology of the distal tibiofibular syndesmosis. PMCT produces high-resolution images that allow for the detailed visualization of the bone structures, including the tibia and fibula. This enables the clear identification of the integrity and alignment of the syndesmosis, as well as any variations or abnormalities. One of the key advantages of PMCT is its ability to generate three-dimensional (3D) reconstructions of skeletal anatomy. This can provide a comprehensive view of the distal tibiofibular syndesmosis in a way that traditional two-dimensional imaging methods cannot, offering detailed insights into the spatial relationships between the tibia and fibula. PMCT is non-invasive and does not require dissection or destruction of the body, making it an ideal method for forensic and clinical research, as well as for postmortem analysis of trauma and injury patterns. The ability to view the syndesmosis without dissection allows for better preservation of anatomical structures, which can be useful in both forensic investigations and orthopedic studies. PMCT has been shown to be effective in identifying syndesmotic injuries, including fractures of the tibia or fibula, ligamentous damage and abnormal separation of the tibia and fibula. For instance, in cases of high-energy trauma or ankle fractures, PMCT can accurately assess the degree of syndesmotic disruption, which is crucial for treatment planning and determining prognosis [5].

Conclusion

The evaluation of the distal tibiofibular syndesmosis is a critical aspect of understanding ankle joint stability and managing injuries related to the lower

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limb. Postmortem Computed Tomography (PMCT) represents a valuable tool in both clinical and forensic settings for assessing the integrity and morphology of the syndesmosis. Its ability to provide high-resolution, three-dimensional images of the skeletal structures makes it an ideal modality for evaluating normal anatomy, identifying variations and diagnosing injuries. PMCT's non-invasive nature, combined with its detailed imaging capabilities, offers significant advantages over traditional diagnostic techniques. As the use of PMCT expands, it is likely that its application in orthopedic and forensic research will continue to grow, offering deeper insights into the complex anatomy of the distal tibiofibular syndesmosis and improving the diagnosis and management of syndesmotic injuries. Ultimately, PMCT has the potential to revolutionize our understanding of syndesmotic anatomy and injury, providing clinicians, researchers and forensic pathologists with an indispensable tool for evaluating the lower extremities and ensuring better outcomes in both clinical and postmortem investigations.

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Conflict of Interest

The author declares there is no conflict of interest associated with this manuscript.

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