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*Editorial*

# Flexions of the Popliteal Artery and the Culture Could Challenge the Outcomes of the Endovascular Procedures

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Recently a hinge point or the maximum bending stress point of the popliteal artery was identified when the knee bends using a lateral view dynamic angiography and a correlation between the lateral view angiography with the extended limb angiography to predict the potential location of the hinge point was defined. A hinge point has been correlated to stent fracture. These findings allowed us to develop a dynamic classification of the popliteal artery. The dynamic classification is useful for endovascular procedures in the popliteal artery. Cultural aspects of our patient population must be considered previous to the endovascular treatment of the popliteal artery, especially to the Japanese culture, which is commonly observed sitting posture such as "seiza (正座)."

***Keywords:*** popliteal artery, endovascular, squatting, culture, vascular surgery, stent

The femoropopliteal arterial segment and particularly the popliteal artery adapts to limb movement. The recent work by Sato et al. studied morphologic changes of the femoropopliteal arterial segment with knee flexion after endovascular therapy.[1] They found that the distal end of the implanted stent was placed above the knee joint line with the knee in extension. The most proximal bending point was about 10 cm above the knee joint line. They concluded that it is important to consider the characteristics and position of the stent to avoid complications.

## Developing a Concept

A hinge point was dynamically identified as the first, main and more angle curve observed in the popliteal artery when the knee bends.[2] A correlation with a bone structure, the medial supracondylar tubercle (MSCT), was found. In addition, a correlation between the MSCT with the superior border of the patella was also established in **Fig. 1**. These anatomical parameters allowed identification of the exact location of the hinge point and a correlation between the knee flexion angiography with the extended limb angiography and thus to predict the potential location of the hinge point. The hinge point location is far superior or proximal compared to the joint line in agreement with the observations presented by Sato et al.[1] Knee bending dynamics and popliteal artery bending dynamics occur at different locations (**Fig. 1**). In the figure, an isolated lesion can be observed to coincide with the upper border of the patella when the limb is extended. With the knee in flexion, the proximity of the isolated lesion to the MSCT is clear (**Fig. 1B**). The superior border of the patella was defined to be at the same level of the MSCT when the limb is in extension, and in this figure, the lesion served as a marker of the hinge point location. In addition, **Fig. 1A** through **1C** show the popliteal artery bending axis and knee bending mechanical axis identified in the figure as 1 and 2 respectively. Further, accessory flexions may also be observed and were described above and below the hinge point of the popliteal artery.[2,3] This prompted the development of the dynamic classification (**Fig. 1D**).

## The Need for a Dynamic Classification

The popliteal artery is divided into P1, P2 and P3 segments based on the classic anatomical classification (**Fig. 1D**). This classification provides a mapping for lesion location that can be used in an angiogram with the leg in exten-

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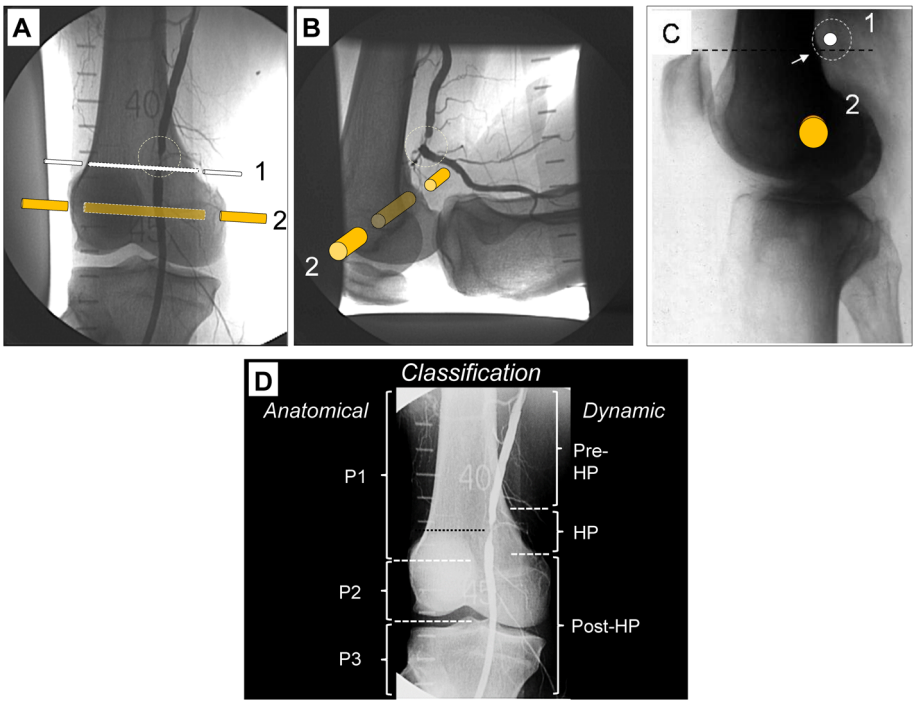


**Fig. 1** Flexions and dynamics parameters of the popliteal artery.
(**A**) Angiogram (front view) of the popliteal artery with one isolated lesion: The dashed circle shows the lesion. Artery bending axis (1) and knee bending axis (2) representations. (**B**) Angiogram (lateral view): Dashed circle showing the lesion and also the hinge point that coincides and knee bending axis representation (2). (**C**) Lateral X-ray view showing: arterial bending axis (1), knee bending axis (2), hinge point location (dashed circle), and the superior border of the patella aligned with the medial supracondylar tubercle or MSCT (black dashed line). (**D**) Popliteal artery classification: anatomical (left) and dynamic (right).

sion. With the development of endovascular procedures including stenting, the classic classification is not adequate to predict arterial flexions in a mobile artery which is subjected to movements. To solve this lack of information, dynamic classification of the popliteal artery was developed based on the discovery of the exact location of the hinge point.[2] This dynamic classification divides the popliteal artery into 3 sectors: the hinge point, the pre-hinge point, and the post-hinge point mapping the location of flexions of the popliteal artery when the knee bends. Although stenting of the popliteal artery is not common, its use is increasing. Flexions of the popliteal artery challenge the outcome of endovascular procedures in this anatomical sector. Mechanical forces, movement repetition, and knee flexion for long periods of time can contribute to a device fracture with or without thrombosis post-trauma.[4] The hinge point or maximum stress zone of the popliteal artery is created when the knee bends, and its angle increases with the degree of knee flexion. The number of flexions and the severity in angle increase are proportional to the increasing degree of knee bending.

## The Need to Sync the Best Technology with the Best Anatomy for Landing

R&D efforts are focusing on design and materials with properties that make stents strong but more flexible to adapt to such an environment.[5] However, we cannot avoid the fact that it is still a foreign body deployed in a mobile artery. The better combination for a successful endovascular procedure in the popliteal artery should include the use of the best device and the best dynamic anatomical information identifying the least mechanical force area. To know where the mechanical force will take place, techniques like side view in flexion[6] or dynamic angiography[2] can be useful.

## Might the Culture Challenge the Outcomes of the Endovascular Procedure?

Finally, from a dynamic perspective, the more the knee bends, the more flexions the popliteal artery develops.[2] It is very interesting that this work by Sato et al.[1] was conducted in Japan. The degree to which culture affects the outcome of an endovascular procedure in the popliteal

artery is unknown but still should be under consideration at the time to indicate and endovascular procedure.[7] Generally, deep squatting posture, a position in which soles of the feet lie flat on the floor and the knees bend more than 100 degrees,[7] is uncommon among European and Europe-derived cultures but more prevalent in Asian cultures.[8] Those that are not culturally accustomed have difficulty maintaining such position, commonly dubbed as the "Asian squat." Specifically, to the Japanese culture, there is a sitting posture known as "seiza (正座)," in which the person kneels on the floor, tucks their legs beneath their thighs, and sits on the heels. Commonly, the Japanese sit in seiza position for culturally traditional settings such as tea ceremonies, martial arts performances, and religious ceremonies for Shintoism and Buddhism. We not only need to be aware of but also respect the culture of our patients. Squatting for religious, eating, meditating, and other cultural purposes is rarely considered or reported at the time of deciding between an open vs. endovascular procedure.[7]

## A Take-home Message

We must understand the total aspect of the patient when deciding whether they are a candidate for endovascular procedures, particularly when a device will be potentially implanted. This includes anatomy, the dynamic difficulties that a stent may introduce in a mobile artery, the cultural aspects that could challenge the outcome of the procedure, the lifestyle of the patient, and of course, the best device possible to confront such challenges. Using a dynamic classification could be very helpful.

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