Clinical application of Shenton's line to determine the femoral artery bifurcation using the antegrade common femoral artery approach

Hui Zhao[1], Liang Zhao[1], Fuxian Zhang[2], Hao Wang[3], Jie Zhang[1], Changbao Yan[1], Peiqiang Geng[1], Yanyang Wang[1], Zongheng Gu[1], Dafang Liu[1], Yihe Geng[1]

[1]Department of Vascular Surgery, Beijing Luhe Hospital, Capital Medical University, Beijing 101100, China;
[2]Department of Vascular Surgery, Beijing Shijitan Hospital, Capital Medical University, Beijing 100038, China;
[3]Department of Orthopaedics, Beijing Tiantan Hospital, Capital Medical University, Beijing 100070, China.

To the Editor: The common femoral artery is the most popular puncture access route for surgical intervention. The distal end of the common femoral artery where the deep femoral artery and the superficial femoral artery bifurcate is difficult to identify, especially when vascular surgeons perform antegrade femoral artery puncture to treat ipsilateral lower extremity artery disease. Many studies have reported methods to anatomically localize the femoral head on the X-ray. Here, we introduce an anatomic landmark, Shenton's line, which refers to the arc line connecting the internal lateral margin of the femur neck and the inferior margin of the pubic bone in a normal anteroposterior radiograph of the pelvis.

Shenton's line is often used by orthopedic surgeons to judge whether hip dislocation or fracture is present. This anatomical mark is very easy to recognize on X-ray. We conducted a retrospective study at our center in which we enrolled patients examined by computed tomography angiography (CTA) to identify the relationship between the Shenton's line on femoral head imaging and the femoral artery bifurcation on X-ray.

This study was approved by the Ethics Committee of Beijing Luhe Hospital, Capital Medical University (No. 2021-LHKY-112-01), and written informed consent was obtained from all patients before their participation. A total of 365 patients with lower extremity CTA among patients with lower extremity arteriosclerosis occlusive disease were assessed at Beijing Luhe Hospital, Capital Medical University from February 2017 to November 2020. Among those, eight cases of femoral head necrosis, 13 cases of femoral neck or intertrochanteric fracture, and six cases of femoral or femoral artery anatomical variation were excluded as they could not be measured. Finally, a total of 338 cases were included. Patients' baseline data, including sex, age, weight, height, and body mass index (BMI), were obtained, and then the relationship between the common femoral artery bifurcation and the midpoint of the femoral head, Shenton's line, and the lower margin of the femoral head was analyzed by CTA. The femoral head was divided into four parts according to the above three lines [Figure 1]. First, the position of the femoral artery bifurcation was determined, and the distance from the three lines was measured. The value was negative when the bifurcation point was above the line, whereas the value was positive when the bifurcation point was below the line. Records were made, and the proportion of bifurcation points in each part was statistically analyzed and the two sides were compared. To exclude the influence of BMI on the femoral artery bifurcation point, we divided patients into four groups according to the Chinese BMI category standards from the Working Group on Obesity in China as follows: underweight (<18.5 kg/m^2), normal weight (18.5–23.9 kg/m^2), overweight (24.0–27.9 kg/m^2), or obese (>28.0 kg/m^2). Statistical analysis was conducted according to the stratification of males and females.

All continuous variables are expressed as mean ± standard deviation. The bifurcation locations of the left and right femoral arteries were compared using the Bowker test. The relationship between the bifurcation location distribution and BMI was examined using the Kruskal–Wallis *H* test. All statistical analyses were conducted using SPSS for Windows Version 26 (SPSS Inc, Chicago, IL, USA). A two-sided *P* value of <0.05 was considered statistically significant. A Venn diagram was constructed using VENNY 2.1 (https://bioinfogp.cnb.csic.es/tools/venny/index.html).

Access this article online

Quick Response Code:

Website: www.cmj.org

DOI: 10.1097/CM9.0000000000001873

Correspondence to: Dr. Liang Zhao, Department of Vascular Surgery, Beijing Luhe Hospital, Capital Medical University, 82 Xinhua South Road, Tongzhou District, Beijing 101100, China
E-Mail: blackjackha@126.com;
Dr. Hao Wang, Department of Orthopaedics, Beijing Tiantan Hospital, Capital Medical University, 199 South Fourth Ring West Road, Fengtai District, Beijing 100070, China
E-Mail: wanghao1980@ccmu.edu.cn

Chinese Medical Journal 2022;135(17)
Received: 08-11-2021; **Online:** 04-01-2022 **Edited by:** Peifang Wei

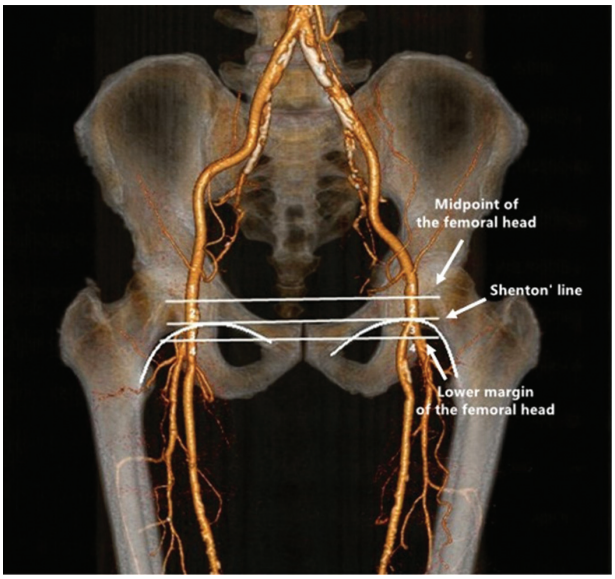

Figure 1: Division of the femoral artery. The femoral head is divided into four parts according to the midpoint of the femoral head, Shenton's line, and the lower margin of the femoral head.

Of the 338 patients, 262 were male (77.5%) and 76 were female (22.5%). The average age of patients was 69.2 ± 9.8 years. Baseline data, such as height, weight, and BMI, were obtained [Supplementary Table 1, http://links.lww.com/CM9/A836]. The artery bifurcation point was located in Zone 1 on the left side in 11 cases (3.3%), in Zone 1 on the right side in 5 cases (1.5%), in Zone 2 on the left side in 41 cases (13.0%), in Zone 2 on the right side in 44 cases (12.1%), in Zone 3 on the left side in 88 cases (26.0%), in Zone 3 on the right side in 82 cases (24.3%), in Zone 4 on the left side in 198 cases (58.6%), and in Zone 4 on the right side in 207 cases (61.2%).

The common femoral artery bifurcation was located below the midpoint of the femoral head on the left side in 327 cases (96.7%) and on the right side in 333 cases (98.5%) and below the Shenton's line on the left side in 286 cases (84.6%) and on the right side in 289 cases (85.5%). In approximately 85.1% (575/676) of patients, the fork points were below the Shenton's line, whereas in about one-third of patients (205/676, 30.3%), the fork points were right on the Shenton's line.

According to this proportion allocation, we defined the biforked point of the femoral artery as "very high" above the midpoint of the femoral head, "high" between the midpoint of the femoral head and the Shenton's line, and "normal" below the Shenton's line. The Bowker test showed no significant difference in the bifurcation locations of the left and right femoral arteries ($\chi^2 = 3.086$, $P = 0.379$) [Supplementary Table 2, http://links.lww.com/CM9/A836]. The bifurcation positions of the left and right common femoral arteries among the 270 patients were the same, with a consistent rate of 79.9% [Supplementary Figure 1, http://links.lww.com/CM9/A836]. This means that if the bifurcation point on one side was high or very high, the probability of having a high or very high puncture point on the other side was significantly higher, whereas if the puncture point on one side was normal, the probability of having a normal puncture point on the other side was increased.

The Kruskal–Wallis *H* test was used for the analysis according to male and female stratification to exclude the effect of BMI on the femoral artery bifurcation, and the results showed no significant difference [Supplementary Table 3, http://links.lww.com/CM9/A836].

In recent years, many scholars have researched how to accurately locate the bifurcation of the distal common femoral artery. Ultrasound guidance is the safest, most reliable, minimally invasive, and accurate method of positioning. However, due to limitations in ultrasonic equipment and operator proficiency, many medical centers are still unable to perform ultrasound guidance.

In practice, the most common method is to locate the femoral head anatomically on the X-ray. Grossman[1] first described observing the femoral head using fluoroscopy in 1974 to help locate the femoral artery. Garrett *et al*[2] showed that in 99% of cases, the femoral artery bifurcates below the midpoint of the femoral head. Yaganti *et al*[3] showed that approximately 95.6% of patients had arterial bifurcation below the central line of the femoral head. We obtained very similar results. Specifically, among Chinese people, 97.6% (660/676) of femoral artery bifurcation points were below the central point of the femoral head, whereas 59.9% (405/676) were below the lower margin of the femoral head.

In our study, we introduced Shenton's line, which is an anatomical marker on the X-ray. We found that the Shenton's line was located between the central point of the femoral head and the lower margin of the femoral head, where many studies have shown the ideal puncture point. Gopalakrishnan *et al*[4] found that the junction of the upper three-quarters and the lower one-quarter of the femoral head (F75) was a better puncture point than the traditional mid-point of the femoral head (F50). We found that the Shenton's line is unusually close to the position of F75. Our study shows that in 85.1% of Chinese people included in this study, the femoral artery bifurcation point is located below or on the Shenton's line, and in nearly one-third of people included in this study, the femoral artery bifurcation point is on the Shenton's line. However, the Shenton's line can be easily identified on the X-ray as the anatomical location of the femoral artery bifurcation point. The results of this study were applied to our clinical work. Of the 52 patients who underwent antegrade puncture at Beijing Luhe Hospital, Capital Medical University from January 2019 to November 2020, 47 cases were successful. In the last 2 years, the technical success rate of antegrade femoral artery puncture has reached >90%. An improvement in puncture success rate can shorten the operation time and improve operation efficiency. Of course, if the femoral artery bifurcation point and the femoral head are confirmed by CTA before surgery, it will be safer and more accurate.

Bilateral femoral artery bifurcation points were compared in this study. Among Chinese people included in

this study, the incidence of a higher puncture point on one side with a higher puncture point on the other side was high. If the bifurcation point is normal on one side, it is more likely that the bifurcation point is normal on the other side. This provides a reference for us to improve the success rate of bilateral puncture. However, in practice, if CTA or prior angiography results are available, it is still necessary to carefully examine imaging data to determine the location of the bifurcation point. BMI had no impact on the femoral artery bifurcation point in this study.

This study has some limitations that should be noted. First, this study is limited by its small sample size. Thus, further studies with larger sample sizes should be conducted in the future. Second, we only included Chinese people in our analysis. Thus, studies should be performed in different ethnic groups to verify the results in other populations.

In 85.1% of Chinese people included in this study, the femoral artery bifurcation point was below or on the Shenton's line, and in approximately one-third of Chinese people included in this study, the femoral artery bifurcation point was on the Shenton's line. There was no significant difference in the bifurcation point of the bilateral femoral artery. Puncture above the Shenton's line is reliable in most cases. Moreover, this anatomical marker is clearer and easier to recognize on X-ray than the midpoint of the femoral head.

Conflicts of interest

None.

References

1. Grossman M. How to miss the profunda femoris. Radiology 1974;111:482. doi: 10.1148/111.2.482.
2. Garrett PD, Eckart RE, Bauch TD, Thompson CM, Stajduhar KC. Fluoroscopic localization of the femoral head as a landmark for common femoral artery cannulation. Catheter Cardiovasc Interv 2005;65:205–207. doi: 10.1002/ccd.20373.
3. Yaganti V, Mejevoi N, Hasan O, Cohen M, Wasty N. Pitfalls associated with the use of current recommendations for fluoroscopy-guided common femoral artery access. Catheter Cardiovasc Interv 2013;81:674–679. doi: 10.1002/ccd.24335.
4. Gopalakrishnan PP, Manoharan P, Shekhar C, Seto A, Sinha R, David M, *et al*. Redefining the fluoroscopic landmarks for common femoral arterial puncture during cardiac catheterization: Femoral angiogram and computed tomography angiogram (FACT) study of common femoral artery anatomy. Catheter Cardiovasc Interv 2019;94:367–375. doi: 10.1002/ccd.27991.

How to cite this article: Zhao H, Zhao L, Zhang F, Wang H, Zhang J, Yan C, Geng P, Wang Y, Gu Z, Liu D, Geng Y. Clinical application of Shenton's line to determine the femoral artery bifurcation using the antegrade common femoral artery approach. Chin Med J 2022;135:2107–2109. doi: 10.1097/CM9.0000000000001873