Femoral canal isthmus is more proximal than apex of curvature in the femurs with greater anteversion of femoral neck.

Yuki Murakami, Mitsuru Hanada[1], Kensuke Hotta[1], Kazuki Nomoto[2], Yukihiro Matsuyama[1]
[1]Hamamatsu University School of Medicine, [2]Hamamatsu University Hospital

INTRODUCTION:

In unstable trochanteric fractures of the femur, long nails are often used for internal fixation. Since the femur of elderly Japanese women has a greater lateral bowing and a stronger bend, it is necessary to be cautious of postoperative excessive neck anteversion and anterior cortical perforation at the distal end of the nail when using long nails. Recently, the use of middle nails has increased to avoid complications due to the mismatch between nail shape and femoral bone morphology. However, the distal locking screw of middle nail are often inserted at the isthmus of the femur or the apex of the femoral curvature, so that there is a risk of postoperative fractures or nail breakage. Therefore, when using middle or long nails for trochanteric fractures of the femur, it is necessary to select nails considering bone morphology, such as neck anteversion, curvature, and the position of the narrowest part.

In this study, we three-dimensionally examined the femoral bone morphology .

METHODS:

We analyzed the CT images using the Zed Hip (LEXI) three-dimensional preoperative planning software for total hip arthroplasty in 77 patients with trochanteric fractures on the unaffected side (14 males and 63 females, average age 87 years).

The following were measured: neck anteversion angle(Figure1A), radius of curvature(R), direction of curvature (positive for lateral curvature)(Figure1B), diameter of isthmus(I) of the medullary canal, length of the narrow area (I+1mm), distance from the top of the greater trochanter (G) to the apex of the curvature (A) (GA), and distance from G to I (GI)(Figure1C). The ratios of the length of the narrow area, GA, and GI to the total length of the femur (from G to the joint line of the knee) were also calculated. Correlations between various measurements were investigated in females.

RESULTS:

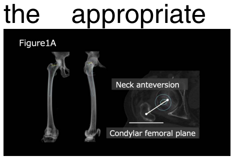
The average values for each measurement item are shown in Table 1. Neck anteversion angle (males 22.7°, females 29.1°, $p = 0.02$) and direction of curvature (males 3.9°, females 15.7°, $p < 0.001$) were significantly greater in females. There were no significant differences in R (males 903mm, females 801mm), diameter of isthmus (males 12mm, females 13mm), length of the narrow area (males 80mm, females 82mm). Overall, the average GI was 168 mm, GA was 181 mm, and IA was 12 mm. While there was no significant difference in the ratio of GI to the total femur length between males and females(males 44%, females 44%), the apex of curvature was more distal and the mismatch between the isthmus and the apex was greater in females(GA:males 45%, females 47%, $p = 0.02$, IA:males 1%, females 4%, $p = 0.03$) (Table 1).

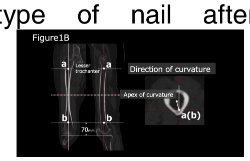
In the correlation analysis focusing on females, significant correlations were found between the neck anteversion angle and direction of curvature ($r = 0.26$, $p = 0.04$), diameter of the isthmus ($r = -0.32$, $p = 0.01$), length of the narrow area ($r = -0.26$, $p = 0.04$), GI ($r = -0.26$, $p = 0.04$), and IA ($r = 0.27$, $p = 0.03$). Greater neck anteversion was associated with greater lateral curvature, smaller diameter of the isthmus, shorter length of the narrow area, more proximal location of the isthmus, and greater mismatch between the isthmus and the apex of curvature(Table 2).

DISCUSSION AND CONCLUSION:

This study found that the isthmus of femoral canal is located at 166mm (44%) and the apex of curvature of the femoral bone is at 181mm (47%). Considering that the distal locking screws of commercially available middle nails are typically positioned around 170mm from the proximal end of the nails, there is a high probability of the screws being inserted at or near the isthmus or the apex of curvature of the femur.

Especially in female patients with large femoral neck anteversion angle, the femur tends to have lateral bowing, small medullary diameter, and mismatch between the isthmus and the apex of the curvature. Therefore, it is necessary to select the appropriate type of nail after thoroughly examination of the patient's femoral bone morphology.





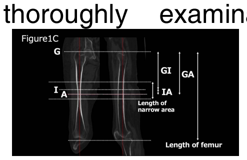


Table1

	Total(n=77)	Male(n=14)	Female(n=63)	P
Age(year)	87.4 ± 6.4 (67〜98)	85.7 ± 5.7	87.8 ± 6.6	0.27
Neck anteversion(°)	27.9 ± 9.0 (9.2〜48.7)	22.7 ± 7.2	29.1 ± 9.0	0.02*
Direction of curvature(°)	13.5 ± 11.6 (-18.7〜39.4)	3.9 ± 9.9	15.7 ± 10.8	<0.001*
R(mm)	820 ± 258 (472〜2184)	903 ±225	801 ± 263	0.18
I(mm)	12.3 ± 2.0 (8.6〜17.5)	11.9 ± 2.2	12.4 ± 2.0	0.38
Length of narrow area(mm)	81.6 ± 26.5 (26〜170)	80.0 ± 18.9	82.0 ± 28.1	0.80
GI(mm)	168 ± 15.6 (130〜210)	177 ± 14.9	166 ± 15.2	0.02*
GA(mm)	181 ± 17.2 (150〜242)	180 ± 13.5	181 ± 18.1	0.95
IA(mm)	12.3 ± 17.7 (-23.5〜60.3)	3.4 ± 14.2	14.3 ± 17.9	0.04*
Length of femur(mm)	385 ± 21.0 (322〜439)	402 ± 17.8	381 ± 19.9	0.001*
Length of narrow area(%)	21.3 ± 7.4 (6.7〜52.9)	20.0 ± 5.1	21.6 ± 7.8	0.47
GI(%)	43.7 ± 3.5 (34.1〜52.1)	44.0 ± 3.5	43.7 ± 3.5	0.72
GA(%)	46.9 ± 3.5 (41.8〜57.5)	44.9 ± 2.9	47.4 ± 3.5	0.02*
IA(%)	3.2 ± 4.5 (-5.9〜15.0)	0.8 ± 3.6	3.7 ± 4.6	0.03*

R radius of curvature, I diameter of isthmus, GI distance from the top of the greater trochanter to I, GA distance from G to the apex of the curvature (A), IA distance from I to A
All values are given in the form of mean±SD

Table2

	Direction of curvature	R	I	Length of narrow area	GI	GA	IA
Neck anteversion	0.26 (0.04) *	−0.18 (0.15)	−0.32 (0.01) *	−0.26 (0.04) *	−0.26 (0.04) *	0.09 (0.50)	0.27 (0.03) *
Direction of curvature	-	−0.29 (0.02) *	−0.09 (0.47)	0.16 (0.22)	0.16 (0.20)	−0.07 (0.61)	−0.17 (0.17)
R	-	-	−0.09 (0.50)	−0.31 (0.01) *	−0.21 (0.10)	0.23 (0.07)	0.34 (<0.01) *
I	-	-	−	0.39 (<0.01) *	0.47 (<0.01) *	0.25 (0.05)	−0.17 (0.17)

All values are given in the form of r(p value), r=correlation coefficient