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Amount of lateral cortex loss in the femur while inserting a DHS-plate

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Aim: Although many anatomic, morphologic, and radiologic studies have been carried out for the femur as for all other bones of the skeletal system, we could not find any morphometric study to guide orthopedic surgeons on dynamic hip screw-plate (DHS-plate) applications of the proximal femur.

Materials and methods: The lateral cortex width of 125 adult, dry, and grossly intact right and left cadaver femora was measured for the region of the femur in which the DHS-plate was applied, and the results were analyzed statistically.

Results: The mean value of the proximal lateral cortex width of the femora was 27.63 mm. While inserting the DHS-plate, 45.24% of the mean width of the lateral cortex was lost.

Conclusion: In this study we demonstrated the amount of lateral cortex loss in the femur while inserting a DHS-plate. New mechanical studies may be needed to show the amount of lateral cortex loss that leads to the fracture.

Key words: DHS-plate, lateral cortex, proximal femur

1. Introduction

The morbidities of patients in orthopedic surgery have been significantly decreased owing to the new technological development of the implants that are being used for different problems of the skeletal system. Soft and bone tissues may be damaged significantly while installing these implants. That is why orthopedic surgeons consider many factors while choosing implants for fixation of bones.

Proximal femoral fractures continue to be a challenge for orthopedic surgeons. The best results will come with minimal damage to the tissues in surgical practice (1). Although many studies have tried to develop new implant devices that use minimally invasive techniques, the dynamic hip screw-plate (DHS-plate) is commonly used in surgeries of the proximal femoral region for various purposes (2,3) (Figure 1). However, while placing, while taking out, or after taking out a DHS-plate, the osteoporotic bone in particular weakens at that region and fracture may happen due to mechanical stress (4). Stress fracture is a known complication of internal orthopedic devices (5).

Although many anatomic, morphologic, and radiologic studies have been carried out for the femur as for all other bones of the skeletal system, we could not find any morphometric study to guide orthopedic surgeons about DHS-plate applications of the proximal femur (6,7,8).

2. Materials and methods

This investigation was performed on 125 adult, dry, and grossly intact cadaver femora. The races, sexes, and ages of the cadavers were not known. Right and left femora were enumerated.

The proximal lateral cortex width (PLCW = α) of the femur was measured with an electronic vernier caliper on the level of the middle of the great trochanter (Figure 2). Usually, a 12.5-mm-diameter hole was opened on the lateral cortex while inserting the 135° DHS-plate in this region (Figure 1).

Maximum, minimum, mean, and standard deviation values of the measures were calculated using Microsoft Excel 2007. These values were compared with the diameter

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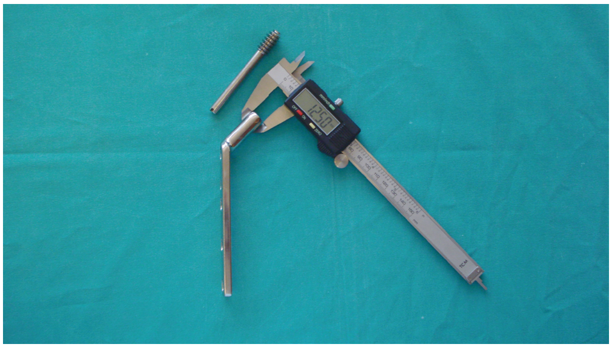

Figure 1. Demonstrative measurement of the barrel portion of the dynamic hip screw-plate by an electronic vernier caliper.

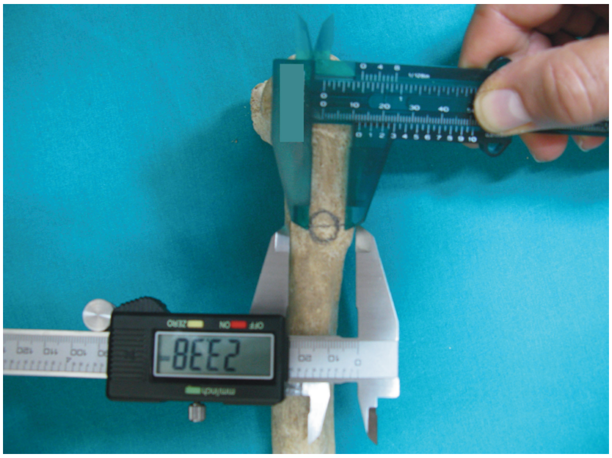

Figure 2. Proximal lateral cortex width (PLCW = α) of the femur measured by an electronic vernier caliper on the level of the middle of the great trochanter.

of the hole that was opened while inserting the DHS-plate. The value of β was calculated as the percentage of the diameter of the hole to the lateral cortex width.

3. Results

The values of the proximal lateral femoral cortex width where the barrel portion of the 135° DHS-plates were inserted are given in Table 1.

The mean value of the proximal lateral cortex width (PLCW = α) of the femora was 27.63 mm (maximum: 34.74 mm, minimum: 19.14 mm, and standard deviation: 3.1144) (Table 2).

Our results also demonstrated that while inserting a DHS-plate, 45.24% of the mean width of the lateral cortex was lost (range: 35.78%–65.3%) (Table 3).

4. Discussion

Many anatomic, morphologic, and radiologic studies have been carried out for the femur as for all other parts of the body (6–9). Some of these studies are discussed in the following paragraphs.

Table 1. The values of proximal lateral femoral cortex width where the barrel portions of the 135° DHS-plates were inserted.

Left femora		Right femora	
No.	A (mm)	No.	A (mm)
1	24.11	1	25.72
2	32.46	2	29.30
3	31.32	3	29.05
4	29.94	4	24.47
5	28.54	5	27.19
6	26.12	6	28.00
7	27.70	7	20.87
8	32.16	8	26.60
9	27.83	9	27.97
10	32.53	10	30.11
11	29.32	11	24.36
12	25.12	12	31.63
13	25.84	13	19.14
14	32.25	14	27.24
15	31.19	15	30.12
16	29.92	16	29.91
17	28.53	17	26.80
18	28.41	18	30.73
19	29.36	19	27.16
20	30.54	20	29.15
21	26.93	21	25.46
22	26.33	22	28.90
23	27.09	23	25.40
24	25.68	24	26.69
25	29.62	25	25.63
26	33.19	26	28.60
27	28.53	27	32.97
28	31.42	28	22.02
29	31.01	29	27.45
30	27.38	30	23.00
31	24.41	31	27.90
32	27.71	32	26.46
33	31.26	33	27.52
34	30.56	34	30.19
35	29.13	35	31.03
36	28.82	36	32.45
37	25.77	37	26.34
38	29.70	38	27.18
39	30.38	39	25.16
40	26.14	40	28.35
41	28.51	41	24.92
42	24.82	42	25.13
43	26.34	43	24.97
44	28.20	44	29.10
45	28.44	45	26.52
46	32.88	46	30.60
47	26.21	47	28.77
48	29.68	48	22.07
49	29.25	49	34.74
50	27.49	50	25.14
51	27.20	51	34.25
52	29.85	52	30.69
53	32.50	53	30.77
54	32.17	54	24.03
55	25.27	55	29.69
56	31.23	56	27.74
57	32.33	57	25.11
58	26.21	58	29.62
59	44.14	59	31.32
60	25.53	60	28.83
		61	25.89
		62	30.92
		63	25.51
		64	26.75
		65	31.46

No.: Numbers of femora. A: The values of the proximal lateral cortex width where the barrel portion of 135° DHS-plates were inserted (millimeters).

Table 2. Values of proximal lateral cortex width (PLCW = α) of the femur.

	Maximum	Minimum	Mean	Standard deviation
PLCW = α	34.74 mm	19.14 mm	27.63 mm	3.1144

Table 3. β values: percentage of the diameter of the barrel portion of the DHS-plate to the lateral cortex width.

λ Values	Maximum	Minimum	Mean
Proximal (DHS-plate)	35.78%	65.30%	45.24%

Stiehl at al. (10) studied the anatomy of the proximal femur in 35 specimens using quantitative computed tomography (QCT). They compared the QCT-derived data with anatomic sections studied by plane radiography and gross dissection. They found the primary supporting structure of the femoral head to be the primary compressive strut, which is a dense column of the trabecular bone projecting from the pressure buttress of the medial femoral neck to the epiphyseal scar. Based on the CT number, the primary compressive strut had similar bone density to cortical structures such as the lesser trochanter, femoral calcar, and posterior lateral femoral cortex.

Irdesel and Ar (11) studied the relationship between the proximal femur morphometry and the bone mineral density, and they suggested that there are positive correlations in the values of the proximal femoral morphometry and bone mineral density. They measured hip axis length, femoral neck axis length, femoral neck width, femoral head width, intertrochanteric width, and Q angle on the radiographs of 190 women. This study showed that higher values of femoral radiographic measures correlate with higher bone mineral density.

Laine et al. (12) studied 50 cadaver femora using computed tomography and a border detection method from 20 mm above the lesser trochanter, the osteotomy level, down to the isthmus to analyze the endosteal dimensions of the proximal femoral medullary canal. They described the variability of the proximal femoral endosteal dimensions in detail and found that the wide variation in the shape and size of the proximal femoral medullary canal means that it is almost impossible to achieve 100% cortical contact with the stem, especially in the metaphysis.

As we mentioned in the previous paragraphs, although there are many anatomic, morphologic, and radiologic studies for the femur, we could not find any morphometric study to guide orthopedic surgeons about DHS-plate applications of the proximal and distal femur. That is why we could not compare the results of past studies with those of our study.

Because there is no study about the amount of cortex loss while installing a DHS-plate, our study is important to help prevent fractures while installing the plates. Although we cannot determine the amount of loss that leads to fracture, it is important to demonstrate the amount of lateral cortex loss while inserting a DHS-plate. Our results demonstrated that while inserting a DHS-plate, 45.24% of the mean width of the lateral cortex was lost.

As a limitation of our study, we can say that it would have been better if we had possessed the cadavers' epidemiologic data (13).

Iatrogenic damage is an important topic in all branches of modern medicine (14). Surgeons must be very careful about not damaging the anterior and posterior cortexes while opening a hole in the lateral cortex for a DHS-plate. In fractures that do not have medial support or that have posterolateral or posteromedial fragments, there may be iatrogenic fracture while using these plates. Nevertheless, orthopedic surgeons who have read this article will probably operate more consciously while using these plates.

In this study we demonstrated the amount of lateral cortex loss in the femur while inserting a DHS-plate. New mechanical studies may also be needed to show the amount of lateral cortex loss that leads to the fracture.

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