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Hip Capsular Repair Affect on Joint Laxity in Total Hip Arthroplasty

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Purpose: Loss of tissue tension around the hip is a cause of hip dislocation. The shuck test is a simple intraoperative test for soft tissue tension. This study evaluated the soft tissue tightness around the hip joint after capsule repair and compared the joint tension resulting from different capsule repair approaches.

Methods: Fifty-three patients underwent a non-cemented total hip replacement using image-free computer-assisted surgery. The patients were divided into the posterior and the anterolateral approach groups. After the hip was reduce, a computer navigation plan was devise to restore proper leg length. The shuck test was applied to determine the soft tissue tension before and after capsule repair. The leg length was recorded after hip reduction and the shuck test. Data from the computer navigation were collected for analysis.

Results The results of this study showed that after the shuck test, the leg length increased by up to 5.98±1.75 mm. (6.73±1.64 mm. and 5.26±1.56 mm for the posterior and anterolateral approach, respectively). After capsule repaire, the leg was shortened by 4.78±1.31 mm. (5.42±1.10 mm. and 4.15±1.20 mm for posterior and anterolateral approach, respectively). The study found that the leg shortening from the posterior approach was significantly higher than the anterolateral approach (p-value <0.001). There were no hip dislocations in this series.

Conclusions: Hip capsule repair improves the soft tissue tension around the hip joint. This helps reduce the risk of hip dislocation. Hip capsule repair using a posterior approach has a better outcome.

Keywords: Arthroplasty, capsule, Hip dislocation, Computer assisted surgery

A total hip replacement is the most efficient treatment for primary or secondary severe osteoarthritis. It relieves the pain associated with arthritis and allows for faster recovery. Hip replacement patients can work and resume routine activities. However, the post-procedural hip arthroplasty, may result in a Leg Length Discrepancy (LLD)[1-4] and/or Dislocation[5-8].

Despite dislocation occurring less frequently, with an incidence of about 3.5%, regardless of the type of surgery[9], it has the greatest impact on the patient's daily life. Theoretically, anterior capsule surgery loses less muscle mass and stability than posterior capsule surgery but is more complicated, resulting in more operative time and increased intraoperative blood loss[10,11]. However, a comparative study in terms of length of hospital stay, use after surgery, pain, hip implant place-

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ment, and complications, including post-operative hip implant dislocation, found no difference[12,13]. The type of surgery chosen depends on the experience and familiarity of the surgeon and the suitability of each patient.

Of all the factors that affect dislocation, the relaxation of the hip capsule tension or the capsule not being repaired[14] was the most frequently found, followed by malposition from the safe zone of the acetabular cup. LLD, the most frequent post-operative complication, can be prevented by prudent planning or by using an assistant in the form of Computer Assisted-Navigation approaches for total hip arthroplasty (CAS)[15] to ensure accurate and precise surgery[16-18].

The "shuck" test"[19-22] is commonly used to evaluate the tension of the hip capsule intra-operatively as it helps a surgeon reconsider the relaxation of the hip joint by adapting the length of the implant or repairing the hip muscle and capsule to reduce the risk of post-operative dislocation[14]. Computer-assisted hip replacements ensure accurate leg length calculation, leading to proper tissue tension around the hip joint[23]. Two suture methods, soft tissue-to-soft tissue, and soft tissue-to-bone, were used for both the anterior and posterior capsules. Studies have found that posterior capsule soft tissue-to-bone repair results in fewer dislocations than soft tissue-to-soft tissue repair or no repair[24-26], and the same result was found in anterior capsule repair[27]. When the posterior approach was compared to the anterior approach regarding treatment outcomes and post-operative complications, there were no significant differences[12,13]. No studies could conclusively conclude that hip capsule repair affects the tension of the post-operative hip capsule.

This study aimed to evaluate the tension of the closed post-operative hip capsule and to compare the anterior and posterior surgical approaches.

Research question

- To study the change in joint tension after the hip capsule was closed.

- To study the differences in joint tension between the anterolateral and posterolateral approaches after the hip capsule was closed.

MATERIALS AND METHODS

A prospective study of 53 hip arthroplasty patients treated at our hospital between April 2016 and January 2021 was carried out. Of these, 27 were treated with the anterolateral approach, and 26 were treated with the posterolateral approach. Patients with chronic joint inflammation, ligament laxity, and previous hip joint trauma with capsular tears were excluded.

Computer-assisted surgery – Total hip arthroplasty (CAS-THA) software: The hip arthroplasty program

All surgery in this study was aided by Computer Assisted-Navigation, i.e., OrthoPilot THA PRO Ver. 3.2 (B. Braun Aesculap Thailand) (Fig 1).

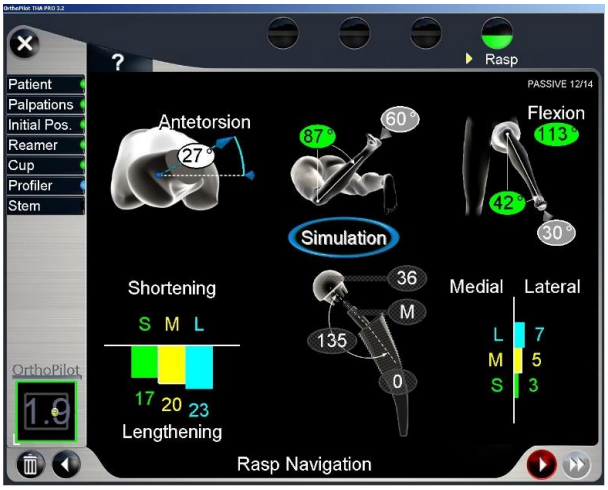

Fig. 1 The hip arthroplasty program: OrthoPilot® Hip Suite THA Pro 3.2.

Total hip arthroplasty surgical procedure

A cementless prosthesis was applied to each patient placed in a semi-lateral decubitus position for the anterolateral approach and in the lateral decubitus position for the posterolateral approach under spinal block. The surgical procedure for total hip arthroplasty (THA) was as follows:

1. Leg length was measured on x-ray images before surgery to ensure minimal post-operative LLD (Fig 2).

2. A skin incision was then made either anterolaterally or posterolaterally.

3. The hip capsule was identified and incised along the length of the femoral neck from the acetabulum to the intertrochanteric line.

4. CAS-THA was performed, and the femoral head was removed from the acetabulum.

5. The acetabulum was assessed, and the hip center was identified and recorded.

6. The femoral neck was cut, the femoral stem size and type (standard or offset) were selected, and the optimal head diameter and neck length could be chosen with the help of the CAS-THA system.

7. The femoral stem and head were then inserted according to the plan devised by the CAS-THA system, and the hip was repositioned. The landmarks that were palpated for referencing were again assessed so that the change in leg length and offset were calculated and displayed, and the data were collected (result 1).

8. The leg was then placed in traction (20 kg) with the shuck test[28]. The leg length, without the capsule closure, was measured with the CAS-THA program. The data were again collected (result 2).

9. Hip capsule closure was performed[29]. The leg was again placed in traction (20 kg) with the shuck test. The leg length was measured with the CAS-THA program. The data were collected (result 3) (Fig 4).

10. Each patient was assessed for instability and range of motion (ROM) [30] before the incision was closed.

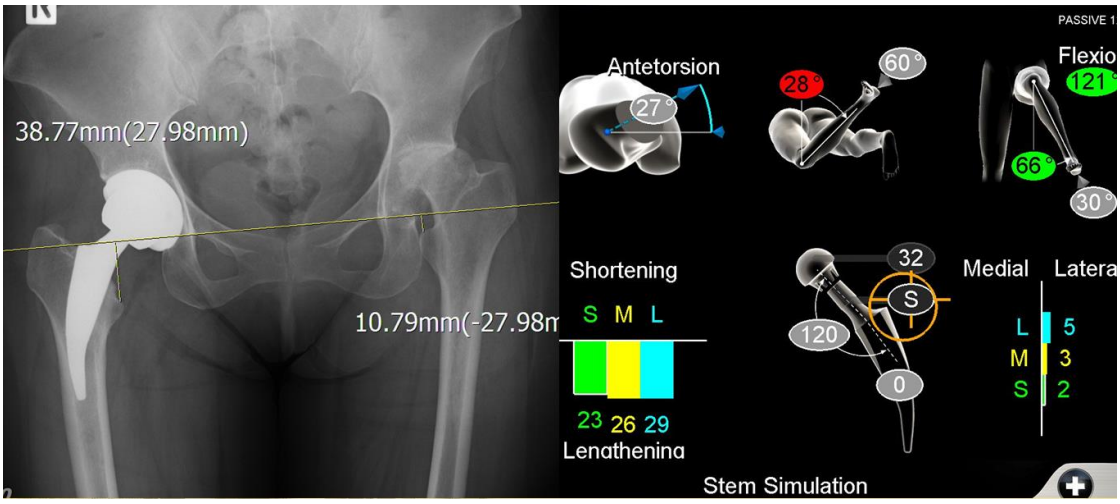

Fig. 2 Assessment of pre-operative leg length (left) was performed with computer-assisted evaluation (right).

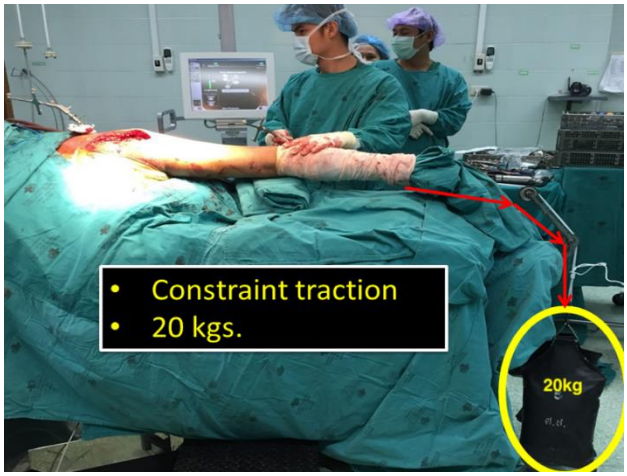

Fig. 3 The leg was stretched under 20 kg traction with the shuck test[28].

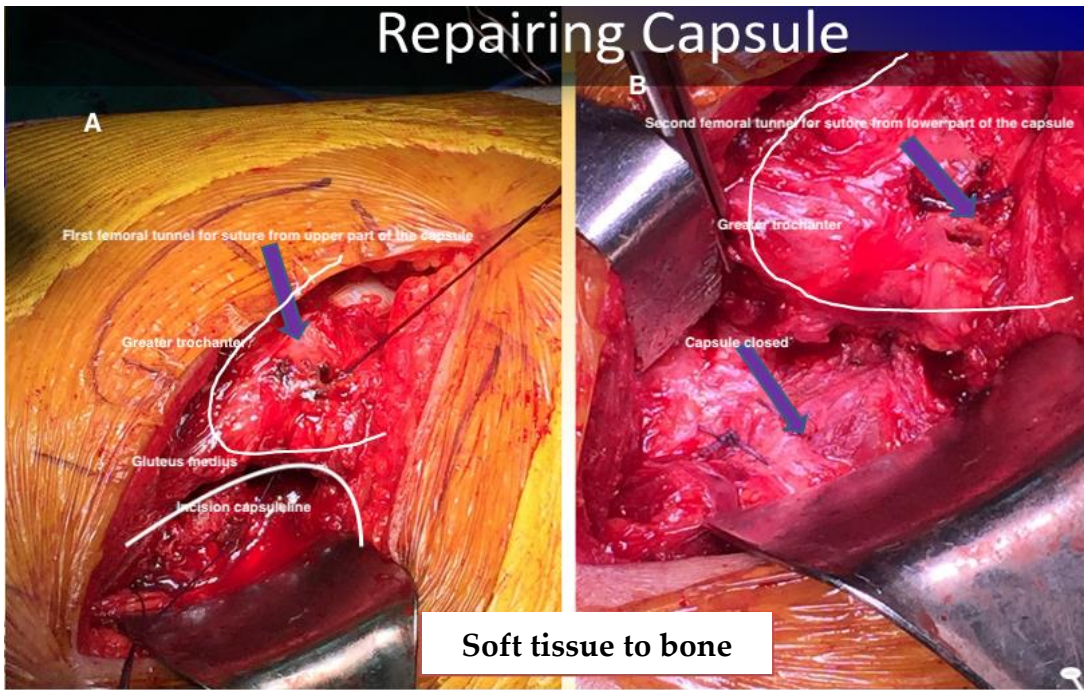

Fig. 4 (A) Suture from the upper part of the hip capsule passing to the femoral tunnel (B) Hip capsule closed with a suture from the lower part of the capsule, passed through the femoral tunnel, and tightened with a suture from the upper part[29].

Statistical analysis

- All analyses were performed using the statistical program SPSS 17.0 (IBM, Armonk, MY, USA). Comparison of repeated measures of leg length (Post-operative, Tele, and at Close of capsule) between the two groups was made using the repeated measures ANOVA.

- A student's t-test was used to compare changes in leg length between the anterior and posterior approaches. A p-value of < 0.05 was set for statistical significance.

RESULTS

Demographics data

The study included 53 patients (68% male) with a mean age of 51.5 (range, 40–59) (table 1). There were no hip dislocations in this cohort.

Leg length in patients undergoing total hip replacement

The mean leg length after reduction was 13.38+5.07 mm, after the shuck test 19.36+5.72 mm, and after capsule closure 14.58+5.66 mm, as illustrated in Table 2.

Table 1 Baseline characteristics (n=53).

Characteristics	Case (n)	Percent
Sex		
Male	35	66.0
Female	18	33.9
Age (year)		
<40	6	11.3
40-49	18	34.0
50-59	18	34.0
60-69	8	15.1
70+	3	5.7
Mean±SD	51.5±10	
Side		
Left	28	52.8
Right	25	47.2

Table 2 Leg-length of post operation, Shuck and Close capsule (n=53).

Length of leg	Mean	SD	Min	Max
Post-operation (mm.)	13.38	5.07	3	23
Shuck (mm.)	19.36	5.72	9	30
Close capsule (mm.)	14.58	5.66	2	26

The change in leg length during the Shuck test before capsule closure was 5.98+1.75 mm, and after capsule closure, it was 4.77+1.31 mm, as illustrated in Table 3.

Comparison of leg length between groups

The outcomes of the shuck test demonstrated that the leg length without capsule closure increased significantly (p<0.001) compared to before it was stretched. The length after capsule closure reduced significantly (p<0.001) compared to the Shuck test without capsule closure (fig 5).

Comparison of changes in leg length between the anterolateral and posterolateral approaches

The posterolateral and anterolateral approaches were compared. The results of the Shuck test (Tele-Post operation) showed that the intra-operative leg length in the posterolateral approach increased significantly (p=0.002). After capsule closure, it decreased significantly (p<0.001) compared to the anterolateral approach.

There was no difference in post-operative leg length after capsule closure between the two approaches (p=0.668), which implies that the loss of tension in the posterolateral approach was recovered after capsule repair, resulting in no difference in post-operative leg length, as illustrated in Table 4.

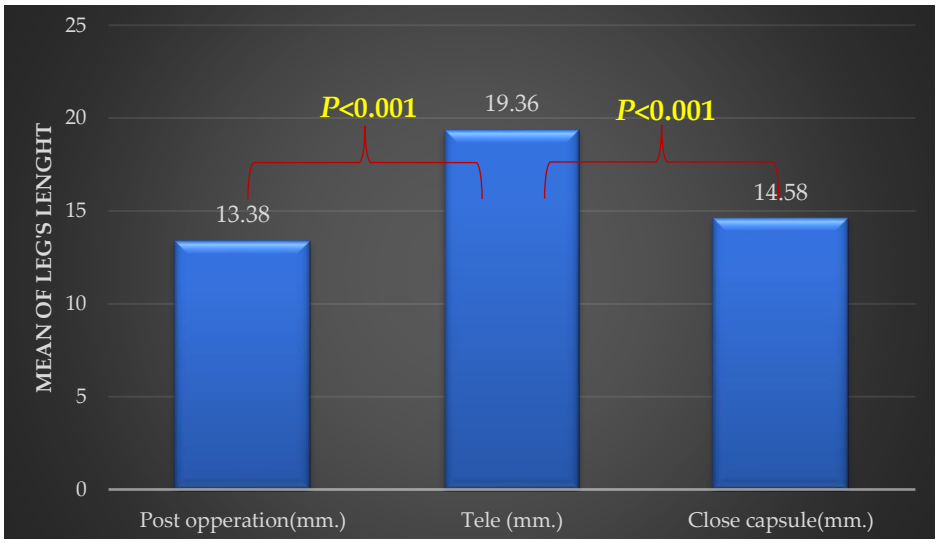

Fig. 5 Leg length Post-operation, during the shuck test, and after capsule closure: P-value from Repeated Measures ANOVA.

Table 3 Change of leg's length.

Change of leg-length	Mean	SD	Min	Max
Shuck-Post operation (mm.)	5.98	1.75	3	11
Shuck-Close capsule	4.78	1.31	2	7

Table 4 Comparison change of leg's length between Anterior and Posterior's operation.

Length of leg	Anterior		Posterior		p-value
	Mean±SD	Min-Max	Mean±SD	Min-Max	
Tele-Post operation (mm.)	5.26±1.56	3-9	6.73±1.64	4-11	0.002*
Tele-Close capsule (mm.)	4.15±1.20	2-7	5.42±1.10	3-7	<0.001*
Close capsule-Post operation (mm.)	1.11±1.45	(-3)-4	1.31±1.85	(-3)-4	0.668

DISCUSSION

In this study, the Shuck test, which involves lower limb traction, showed the relaxation of the hip capsule and an increase in post-operative leg length of 5.98±1.75 mm. The hip capsule became more constrictive after capsule closure, which resulted in a decrease in post-operative leg length of 4.77±1.31 mm on the Shuck test. The post-operative leg length with capsule closure was evaluated by digital software, which provided greater validity than previous studies. The factors associated with a hip dislocation, such as alignment of the acetabulum cup, neck length, caput-collum-diaphyseal (CCD) angle of the stem, offset, and hip tension, were assessed using the CAS-THA system. There was a significant decrease in hip joint stability before capsule repair, with a statistically significant increase in joint after capsule repair.

The closed capsule leg length in the posterolateral approach decreased significantly ($p < 0.001$) compared to the anterolateral approach. There was more relaxation of the hip capsule in patients undergoing the posterolateral approach, as shown by the LLD, which increased by 6.73±1.64 mm in the posterolateral group and by 5.26±1.56 mm in the anterolateral group. This could be treated with capsule closure. This is in keeping with previous studies, which found that soft tissue-to-bone repair in the posterior hip joint capsules resulted in dislocation occurring less often than soft tissue-to-soft tissue repair or non-repair[24-26]. The same result was seen in anterior capsule repair[27]. The current study has shown that capsule closer from both sides resulted in a decrease in post-operative leg length from 5.26±1.56 mm to 1.11±1.45 mm for the anterolateral approach and from 6.73±1.64 mm to 1.31±1.85 mm for the posterolateral approach which implies an increase in tension of about 20% both sides. In a situation where there is an LLD with loss of some tension, repairing the capsule is the one option that can solve this problem without comprising the other factors that are associated with hip dislocation, such as alignment of acetabulum cup, neck length, CCD angle of stem, and offset.

Dislocation caused by the relaxation of hip capsule tension has been found in several previous studies. Capsule closure improving hip capsule tension has been shown in this study to reduce the possibility of dislocation, and a study by Agarwal S showed that the use of computer navigation resulted in a lower revision rate for dislocation in the CAS-THA cohort. The cumulative percentage revision for dislocation at ten years was 0.4 for navigation (or CAS) compared with 0.8% for non-assisted THAs, and in the five component combinations most commonly used with navigation, the rate of all-cause revision was significantly lower when these components were navigated compared with non-navigated, the cumulative percent revision at ten years for these five prostheses combined was 2.4% for the navigated group compared to 4.2% for the non-navigated THA[30].

CONCLUSIONS

- Post-operative closure of the hip capsule results in increased tension on both sides of the hip and can diminish post-operative dislocation[24, 25].

- The change in hip tension after capsule closure was greater in the posterolateral approach group than in the anterolateral approach group.

- Post-operative capsule closure should be applied to every total hip replacement patient, especially when using the posterolateral approach.

- The use of computer-assisted navigation influences the validity and accuracy of this study and differentiates it from previous research.

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