Positioning of Femoral Tunnel in Anterior Cruciate Ligament Reconstruction Using Femoral Aimer Guide

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Objectives: *Anterior Cruciate Ligament (ACL) reconstruction is one of the common procedures. A larger number of ACL injury patients seek treatment to return to preinjury level. Many factors affect the result of reconstruction. Femoral position is one of the important factors. Nowadays, Femoral Aimer Guide is used in to find the proper position of the femoral tunnel but Grontvedt,et al reported the technique was unsatisfactory. Some studies show it is impossible to use the device via transtibial technique for anatomical attachment at femoral site.[22-23] The authors studied the femoral entry point by using the Femoral Aimer Guide both through transtibial tunnel and medial arthrotomy approach.*

Material and Method: *The authors dissected 37 cadaveric knees, removed the ACL and identified the center of the ACL attachment at the femoral side. Used the Femoral Aimer Guide in assisted to find the position of the femoral entry point at 90 position. Right knee by transtibial technique and left knee by medial arthrotomy technique. Both positions were compared.*

Results: *All positions from the Femoral Aimer Guide entry point did not coincide with isometric point. They tended to move more superior and posterior positions. Some of the aimer positions were far more posterior, and caused the posterior cortex to be thinner than 5 mm.*

Conclusion: *The Femoral Aimer Guide couldn't find the proper position of graft attachment at the femoral side by the standard technique.*

Keywords: *ACL reconstruction, Femoral Aimer Guide, Isometric point*

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Anterior Cruciate Ligament Reconstruction has become a common surgical technique. Result of operative treatment better than conservative[1-11] and a large number of intra-articular and extra-articular procedures have been described. Most surgeons prefer intra-articular reconstruction because it provides predictably good results[7-11].

The success of reconstruction depends on 3 major factors: biologic, mechanical and post operative program. In detail graft selection and harvesting technique, femoral and tibial tunnel placement, graft tension and graft fixation are also important[12-17]. The surgical outcome depends on the ability of the substitute to reproduce the restraining action of the ACL and restore the normal kinematics of the knee.

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Positioning of the femoral attachment tunnel has a much larger effect on graft tension during flexion and extension[16-18]; the consequences are not only fixation failure and limitation of knee motion but include excessive graft wear, synovitis, poor vascularity and myxoid degeneration[13]. Recognition of these problems has led many surgeons to seek proper graft tunnel location where separation distance remains nearly constant, or isometric. However no femoral attachments are completely isometric. Although, a recent study has demonstrated that proper femoral attachment should produce the graft length change of 2 mm or less during knee motion[19-22].

The purposes of the present study was to determine the femoral entry point of the Femoral Aimer Guide using both transtibial tunnel and medial arthrotomy technique, in relation with the isometric point.

Material and Method

20 pairs of cadaveric lower extremities were dissected and the anterior cruciate ligaments excised through the medial parapatellar arthrotomy. One cadaver was excluded due to severe varus knee. 1 left knee was excluded from malunion of fracture tibia with gross deformity. Transtibial technique was used in 19 right knees in preparing the femoral tunnel entry point. The tibial tunnel was located by placing the tip of the tibial tunnel guide 5-7 mm anterior to the Posterior Cruciate Ligament (PCL) attachment. The tunnel was created by 10 mm diameter drill. The Femoral Aimer Guide(Paramax Femoral Bullseye Guide of Linvatec, Largo, Florida) was passed through the tibial tunnel in knee 90 flexion and placed at over the top position, then rotated the arm of guide and aimed at 11:00 o'clock position (Fig. 1). The femoral tunnel entry point was marked by the Kirschner wire drilling hole. In the other 18 left knees, the anteromedial approach of the Femoral Aimer Guide was used (Fig. 2). The knee was flexed to 90 and the Femoral Aimer Guide was placed over the top position then rotated to aim at the 1:00 o'clock position. The femoral tunnel entry point was marked by Kirschner wire drilling hole.

The 37 knees were dissected to remove the soft tissue and lateral femoral condyle was cut as a block. Identifying the center of Anterior Cruciate Ligament (ACL) femoral insertion footprint (point **c** in Fig. 3). This point represents the isometric point of Anterior Cruciate Ligament insertion. Drawing the line **ac** perpendicular to the long axis of the distal femur; **a** is the point where the line transects the cartilaginous rim. Draw the second line **cb** at the right angle to line **ac** and transect the articular cartilaginous rim at **b** (Fig. 3). Then measure the distance of **ac** and **cb**. Using the femoral aimer guide femoral tunnel entry point **C**, then draw the line **AC** and **CB** in the same measure as **ac** and **cb**, **cd** is the line draw from the roof of the inter-condylar notch to the isometric point **c** in the coronal plane (Fig. 3). Then measure the distance of **ac** and **cb**, the distance of **Cc** and angle of **acC**.

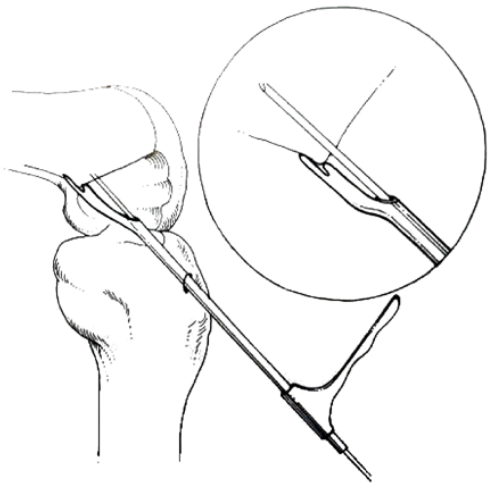

Fig. 1 Transtibial technique

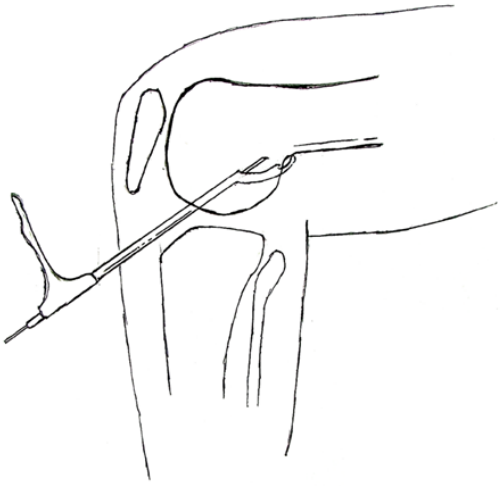

Fig. 2 Medial arthrotomy approach

Results

Femoral Aimer Guide point: C

In 19 right knees that used the transtibial approach, the authors found the average distance of **AC** was 8.58 mm (3.65-13.72) **BC** was 12.17 mm (6.84-18.5) and **Cd** was 7.22 mm (3.35-12.14) The average angle of posterior deviation **acC** = 3.68 .

About 18 left sides, the medial arthrotomy approach, the authors found the average distance of **AC** was 9.63 mm (3.52-15.02) **BC** was 10.96 mm (8.35-15.11) and **Cd** was 8.03 mm (3.55-13.76) The average angle of posterior deviation **acC** = 2.89 (Table 1).

Using Isometric point: C

In 18 right knees with transtibial approach the average distance from the isometric point to the condylar rim, **ac** was 11.99 mm (range 8.74-16.04 mm), **bc** was 11.5 mm (7.37-16.75), **cd** was 9.9mm (7.14-13.47). The average angle of posterior deviation and the distance **Cc** was 10.36 mm (Table 2).

In 18 left knees with medial arthrotomy approach, the authors found the average distance from the isometric point to the condylar rim, **ac** was

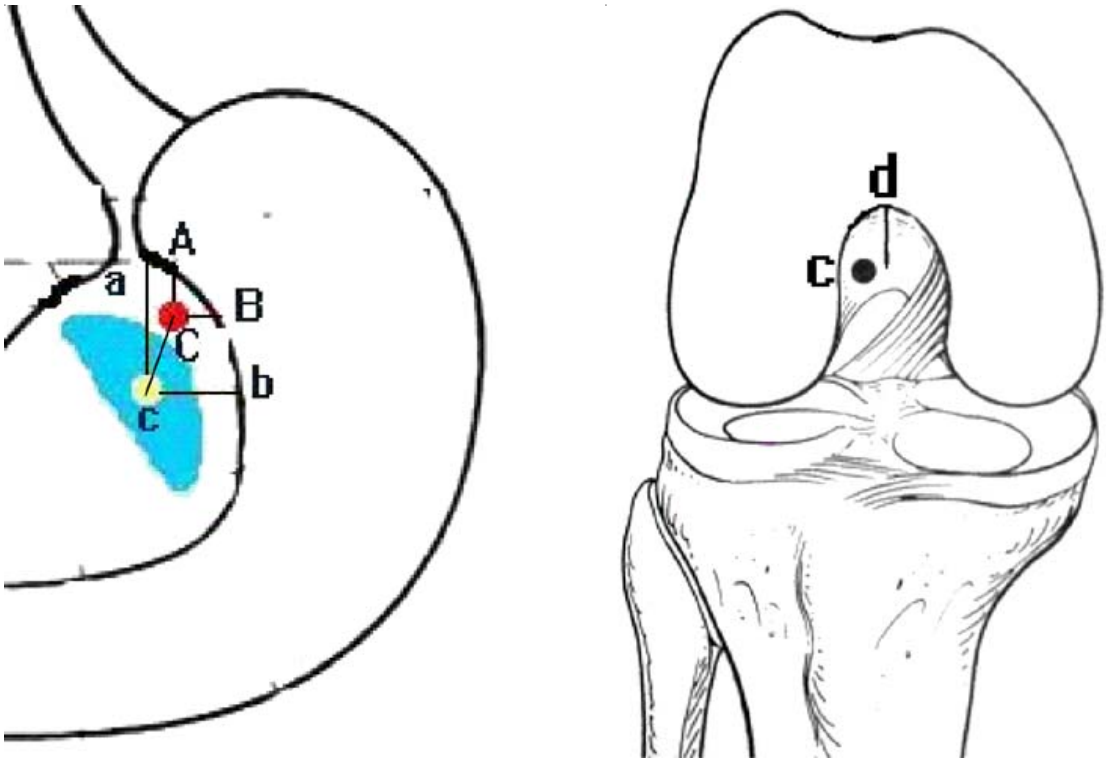

Fig. 3 **c** is the ACL isometric point, the line **ac** is perpendicular to the long axis of distal femur, **bc** is at right angle to **ac**. **C** is the femoral Aimer Guide entry point, the line **AC** is perpendicular to the long axis of distal femur, **CB** is at right angle to **ac**. **d** is highest point of intercondylar roof. **cd** is distance from **d** to **c** point. **acC** angle is angle between line **ac** and **cC**

14.18 mm (11.72-16.74) **bc** was 10.41 mm (8.83-13.57) **cd** was 10.44mm (8.24-15.21) and the distance **Cc** was 9.67 mm (Table 2).

Discussion

Anterior Cruciate Ligament injury is a common problem, especially in sport activity person. Improper treatment leads to instability knee, disability and early degenerative change. ACL reconstruction is a procedure for effective treatment and many studies reported good results as compared with conservative treatment.

Proper selection of the ACL attachment sites will result in preventing the graft from becoming excessively tense and thereby constraining joint motion which produced abnormal compression loads or causing failure at the fixation points. Since no femoral attachments were completely isometric, Mohamed SH found that the femoral attachment that produced the smallest change in tibiofemoral distance, 2 mm or less is located near the center of the ACL' s femoral insertion.

If the femoral attachment is placed too far anteriorly, the tibiofemoral distance will increase with flexion. This will stretch the graft and constraint to anterior tibial translation as the knee is flexed. If the femoral attachment is too posterior, the graft will became slack with flexion resulting in an increased anterior tibial translation.

The authors found that by using the Femoral Aiming Guide (Bull's eye) in both the transtibial tunnel technique and arthrotomy technique and placing the guide to the femoral condyle as recommended (11:00 o'clock in right knee and 1:00 o'clock in left knee). The average femoral entry point is located relatively anterosuperior to the isometric point. That will result in too far anterior and vertical position of the graft. If the femoral Aimer guide is rotated to the position of 9-10 o'clock in the right knee and 2-3 o'clock in the left knee, the center of the femoral tunnel will located near the center of the ACL attachment, isometric point.

The authors found the cd distance was about 10 mm in knee flexion 90 . This distance will guide and

Table 1. Distance from Femoral Aimer Guide Point (**C**) to cortical rim and **acC** angle

Rightside					Leftside			
BC	AC	cd	acC		BC	AC	cd	acC
13.65	11.43	9.7	2		10.24	8.93	6.56	-3
12.55	7.25	6.45	-9		8.74	8.05	7.63	-2
10.42	6.79	5.83	-6		12.64	13.24	13.76	5
10.47	8.25	7.59	-4		10.48	13.35	11.13	6
9.79	6.87	5.48	-6		9.85	7.94	5.07	2
10.48	7.05	6.04	-5		8.35	12.15	9.21	2
10.79	9.34	7.98	-4		10.47	9.56	7.58	3
9.35	7.87	6.68	-4		9.38	7.82	7.02	6
9.82	8.26	6.75	2		11.46	11.25	9.82	8
8.97	7.35	5.52	-3		9.96	6.45	5.23	-2
8.54	6.48	5.72	4		14.15	10.13	7.24	0
15.86	9.53	7.24	-6		13.47	15.02	12.18	12
13.45	8.29	7.75	-2		8.59	9.33	7.45	3
11.53	7.45	5.64	-2		9.76	9.31	7.25	3
18.15	12.22	9.87	-5		13.02	10.12	9.63	-1
18.5	11.94	9.55	-5		9.14	8.03	6.85	1
6.84	3.65	3.35	-2		12.43	9.14	7.43	4
15.72	9.35	7.85	-5		15.11	3.52	3.55	5
16.35	13.72	12.14	-10					
12.17	8.58	7.22	-3.68	Average	10.96	9.63	8.03	2.89

Table 2. Distance from Isometric Point (**c**) to cortical rim and to Femoral Aimer Guide Point (**C**)

RightSide					LeftSide			
Bc	ac	cd	Cc		bc	ac	cd	Cc
14.87	11.15	7.24	8.46		10.50	13.11	9.16	10.37
11.35	13.22	11.14	11.09		12.14	14.28	8.47	12.05
13.65	9.58	9.26	10.63		9.97	15.42	9.15	7.06
10.40	11.44	9.05	10.52		11.62	14.28	9.28	6.42
9.28	10.35	9.27	12.04		9.46	12.21	11.24	9.66
10.49	16.04	7.14	11.76		10.24	14.35	11.18	7.46
10.16	10.25	10.58	11.36		10.85	15.37	8.57	11.92
7.37	9.26	9.83	10.25		8.83	13.47	12.26	12.13
7.92	9.34	7.45	8.02		10.45	16.74	15.21	11.34
8.54	10.37	10.44	10.74		11.54	15.53	10.62	13.74
13.27	15.14	11.42	11.74		13.57	12.96	8.24	6.15
11.64	11.49	13.47	13.18		9.18	13.74	12.82	9.12
12.44	15.92	9.85	8.32		9.25	14.25	10.65	9.20
15.04	13.18	10.63	10.74		9.24	15.41	9.20	9.43
14.52	8.74	9.25	6.74		8.89	11.72	8.95	6.04
16.75	12.56	8.02	6.02		10.60	15.26	11.22	9.83
9.87	13.62	11.45	18.47		10.34	13.62	11.40	8.48
10.62	12.64	12.05	8.42		10.62	13.56	10.23	13.72
10.15	13.64	10.62	8.45					
11.50	11.99	9.90	10.36	Average	10.41	14.18	10.44	9.67

recheck the isometric position in the sagital plane and help to avoid resident ridge or other bony prominence. By using the Femoral Aimer Guide in cadaveric knees, the authors found more than half of the back wall of the entry point was less than 10 mm if we use the large size drill, the back wall bony stock may be inadequate and can be broken during screw fixation

Further study in a larger sample size and new technique or a new design of the Femoral Aimer Guide should be done. Position setting, a technique for clear visual surgical field and surgeon experience to adapt individually are still important for a good result of ACL reconstruction.

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ความผิดพลาดในการวางตำแหน่งเครื่องมือ Femoral Aimer Guide ในการผ่าตัดสร้างเอ็นไขว้เข่าหน้าเทียม

นัฐวุฒิ วิวรรธนวรางค์, วัชระ รุจิเวชพงศธร

วัตถุประสงค์: เอ็นไขว้หน้าที่เข่าขาดเป็นปัญหาที่พบได้บ่อยทางออร์โธปิดิกส์ การรักษาโดยการผ่าตัดที่ยอมรับและใช้กันทั่วไปคือการผ่าตัดสร้างเอ็นไขว้หน้าทดแทนเอ็นเส้นเดิม และผลหลังผ่าตัดมีผู้ป่วยจำนวนมากสามารถกลับไปทำกิจกรรมได้ใกล้เคียงกับก่อนการบาดเจ็บ แต่อย่างไรก็ตามยังมีปัจจัยหลายประการที่ส่งผลถึงการรักษา รวมถึงตำแหน่งของเส้นเอ็นเทียมทางด้านกระดูกต้นขา โดยทั่วไปแพทย์ผู้ผ่าตัดจะหาตำแหน่งดังกล่าว จากการใช้เครื่องมือ Femoral Aimer Guide แต่ในระยะหลังมีรายงานบางฉบับรายงานถึงตำแหน่งที่ได้จาก การใช้เครื่องมือดังกล่าวไม่ใช่ตำแหน่งที่เหมาะสม ทางคณะผู้วิจัยจึงต้องการศึกษาผลจากการใช้เครื่องมือดังกล่าว ว่าจะได้ตำแหน่งที่เหมาะสมสำหรับเส้นเอ็นเทียมหรือไม่

วัสดุและวิธีการ: ทำการชำแหละเข่าจาก cadaver จำนวน37เข่า ตัดเอ็นไขว้หน้าและหาจุดกึ่งกลางของที่เกาะทางด้านกระดูกต้นขา ใช้เครื่องมือ Femoral Aimer Guide หาตำแหน่งที่เกาะของเส้นเอ็นเทียมในท่าเข่างอ 90 โดยเข่าขวาใช้เครื่องมือผ่านทางTibial tunnel ส่วนเข่าซ้ายผ่านทาง Medial arthrotomy หลังจากนั้นเปรียบเทียบจุดทั้งสองที่ได้

ผลการศึกษา: ตำแหน่งที่ได้จากการใช้Femoral Aimer Guideเป็นคนละจุดกันกับ Isometric point โดยตำแหน่งที่ได้จะค่อนไปทางด้านบนและหลังต่อ Isometric point นอกจากนั้นยังพบว่าบางจุดอยู่ห่างจากขอบกระดูกน้อยกว่า 10 มม. ทำให้หลังจากยึดเส้นเอ็นเทียมจะเหลือขอบกระดูกน้อยกว่า 5 มม.

สรุป: การใช้Femoral Aimer Guideไม่ช่วยให้ได้ตำแหน่งที่เหมาะสมสำหรับการสร้างเส้นเอ็นไขว้หน้าเทียม