Comparison Of Free Hand Versus Offset Guide Technique For Femoral Tunnel Placement In Arthroscopic Anterior Cruciate Ligament Reconstruction

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Abstract

Background: Accurate femoral tunnel placement is one of the most crucial steps of ACL reconstruction, and also a predictor of better outcome. This study was done to compare two methods of femoral tunnel drilling, freehand method and offset guide method and to assess them by 3D CT Scan using Bernhard Hertel quadrant to find out which is better method of tunnel placement.

Material and methods: 30 patients, who underwent arthroscopic ACL reconstruction from June 2018 to April 2020, were compared for the femoral tunnel placement by freehand and offset methods and were assessed by postoperative 3D CT Scan. Height and length of femoral tunnel and the percentage of femoral height (h) and length (t) to the total height and length respectively were calculated on the Bernhard Hertel quadrant and compared.

Results: The mean 'h' was 28.62 ± 7.68 (range 15.5 to 42), while mean of 't' was 34.86 ± 9 (range 21.5 to 55.5) in free hand method. The mean 'h' was 28.65 ± 10.19 (range 11.6 to 58), while mean of 't' was 31.6 ± 5.02 (range 21.8 to 44.4) in femoral offset guide method. On comparing mean of "h" of freehand method with the mean of "h" of offset guide method, the p value was 0.984 (p value > 0.05), which was not significant. Similarly, on comparing mean of "t" of freehand method with the mean of "t" of offset guide method, the p value was 0.230 (p value > 0.05), which was not significant.

Conclusion: Femoral tunnel preparation leads to almost similar tunnel position by both freehand and offset guide method. Both methods are associated with surgeon's learning curve. 3D CT-Scan and Bernhard Hertel grid is reliable and reproducible method for evaluating femoral tunnel.

Keywords: ACL Reconstruction, Femoral Tunnel placement, Bernhard Hertel quadrant, Free hand method, Offset guide method.

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Introduction

Arthroscopic ACL reconstruction has proven efficacy and a low morbidity profile. Techniques in ACL reconstruction have further improved significantly over the last several decades because of increased prevalence of these surgeries, better ACL understanding, intensive researches and studies on ACL and considerable attention on outcomes of ACL surgery. Current researches on ACL focus on tunnel positioning, graft choices, fixation methods and postoperative rehabilitation protocols [1,2]. Among various available graft options, hamstring is the most commonly used graft and is the preferred choice for arthroscopic ACL reconstruction [3].

Accurate tunnel placement and graft positioning are important for successful anterior cruciate ligament (ACL) reconstruction. Inaccurate femoral tunnel placement is among, one of the most frequent cause of errors in failed anterior cruciate ligament reconstructions [4,5]. In order to find the efficacy of placement of femoral tunnel, we compared the placement of graft in femoral tunnel by offset guide method versus free hand technique and assessed the femoral tunnel placement by post-operative 3D CT-scan.

Material and methods

30 patients of primary ACL tear, operated from June 2018 to April 2020 at our centre for arthroscopic ACL reconstruction were included in the study. The study was approved by institutional ethical review committee and written informed consent was obtained by all the patients. All patients undergoing primary ACL reconstruction with hamstring graft, with age more than 15 years and willing to give consent for surgery were included in the study. Patients with pre-existing congenital/developmental/collagen diseases, associated life threatening injury/illness, revision ACL reconstruction surgery, ACL injuries with avulsion injuries or associated intra-articular condylar fractures, arthritic knee or septic knee joint were excluded from study.

All patients were operated under spinal anaesthesia under tourniquet with use of hamstring graft for arthroscopic ACL reconstruction. Arthroscopic ACL reconstruction was done by standard steps. Femoral tunnel was made at the foot print of the native ACL after removal of its debris, with knee flexed at 120^0 or more. Guide wire was passed through the AM portal. The femoral tunnel was placed either with use 7^0 offset guide (fig1) or by free hand drilling technique of femoral tunnel under vision of arthroscope, camera unit and video screen along with continuous irrigation at optimum pressure which provided better visualization. The groups were randomized as per odd (offset guide) and even (free hand method) method. Guide wire was passed through AM portal and reaming done in proportion of thickness of graft obtained (fig 2).

Postoperatively standard post-operative rehabilitation protocol was followed. Post-operatively, 3D CT scan was done to determine the femoral tunnel positions by use of Bernard and Hertel quadrant method and 3D reconstruction model of distal femur were made using volume rendering technique (VRT). Initially, the distal femur model was positioned horizontally in strict lateral position, where both femoral condyles were superimposed. The model was then rotated to a distal view, and medial femoral condyle was virtually removed at the highest point of the anterior aperture of the intercondylar notch leaving lateral femoral condyle. Finally, the model was rotated back to the strict lateral position which provided end on view of medial wall of lateral femoral condyle and the femoral tunnel without any hindrance from medial condyle. Then the position of the centre of femoral tunnel was measured through Bernard and Hertel quadrant method. Total height (H) was measure of the perpendicular line from the Blumensaat line till the tip of articular end on condyle (proximal to distal). Total length (T) was measure of the parallel line to Blumensaat line at intercondylar point (from anterior to posterior). Femoral tunnel height (h′) and length (t′) was measured from the centre of the femoral tunnel on the perpendicular to the Bluemensaat line till the proximal end and on the parallel to the Bluemensaat line till the posterior end. Percentage of femoral tunnel centre height (h) and length (t) was measured in percentage as the ratio of femoral tunnel height (h′) to total height (H) and ratio of femoral tunnel length (t′) to total length (T) respectively (fig 3).

Result

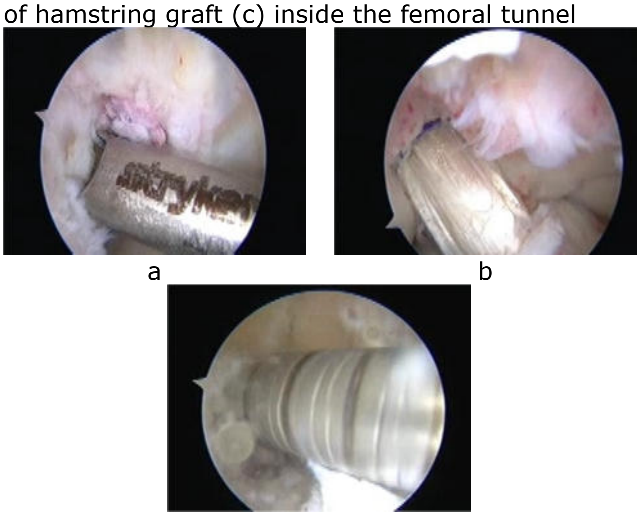
30 cases of arthroscopic ACL reconstruction using hamstring graft with mean age of 30.5 years (range 17 to 45 years) were included in the study. 26 patients were male (86.7%) and 4 females (13.3%). Left ACL tear was seen in 16 patients (53.3%) while right ACL tear was

seen in 14 patients (46.7%). 15 patients were there in each group of free hand technique and offset guide method.

In 15 patients of free hand method of femoral tunnel drilling, the mean percentage of femoral tunnel centre height 'h' was 28.62 ± 7.68 (range 15.5 to 42), while mean percentage of femoral tunnel centre length 't' was 34.86 ± 9 (range 21.5 to 55.5). In 15 patients of offset guide method of femoral tunnel drilling, the mean 'h' was 28.65 ± 10.19 (range 11.6 to 58), while mean of 't' was 31.6 ± 5.02 (range 21.8 to 44.4).

Fig 1. Femoral tunnel offset guides

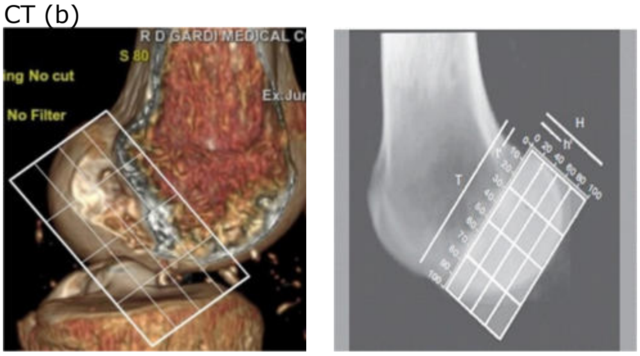
Fig 2. Intraoperative arthroscopic photos showing use of offset guide (a), for drilling (b) and passage of hamstring graft (c) inside the femoral tunnel



a b

c

Fig 3. Bernard and Hertel quadrant method on 3D CT reconstruction model (a) & on sagittal section of CT (b)



a b

On comparing means "h" (percentage of femoral tunnel centre height) of freehand method with the mean "h" of offset guide method, the p value was 0.984 (p value > 0.05), which was not significant. Similarly, on comparing means "t" (percentage of femoral tunnel centre length) of freehand method with the mean "t" of offset guide method, the p value was 0.230 (p value > 0.05), which was also not significant.

Table 1. Comparing femoral tunnel in different studies

Studies	h	t
Fernandes et al [11]	35.9±10.4	20.9± 3.6
Piefer et al [12]	44.2	28.5
Kim et al (expert surgeon) [13]	32.6± 4.3	30.5 ± 4.6
Kim et al (Novice surgeon) [13]	31.6± 4.6	32.5± 3.7
Kawaguchi et al [16]	31.7	32.4
In our study by free hand	**28.62± 7.7**	**34.86± 9**
In our study by offset guide method	**28.65± 10**	**31.66± 5**

Discussion

Tunnel positioning, graft choices, fixation methods and postoperative rehabilitation protocols are the key factors for the success of an arthroscopic ACL reconstruction [1-3]. Accurate femoral tunnel position is must for excellent outcome of ACL reconstruction. Among the causes of failed arthroscopic ACL reconstruction, inaccurate femoral tunnel positioning is one of the most frequent cause [4,5].

Various methods for femoral tunnel placement are anatomical landmark methods e.g. lateral bifurcated ridge, lateral intercondylar ridge etc but identifying these anatomic landmark in chronic ACL tear is challenging and these land marks may vary as shown by studies by Ferretti et al and Tsukada et al [6,7]. Free hand and offset guide methods are among the two most commonly performed methods for femoral tunnel positioning. Among various methods to assess the accuracy of femoral tunnel placement, Bernhard Hertel grid method by 3D CT scan is easy, reliable and reproducible method for assessing the femoral tunnel placement [6-11]. Placement methods of femoral tunnel positioning have not been compared and there is lack of consensus regarding the ideal method of femoral tunnel placement. Hence, in order to find the efficacy of methods of placement of femoral tunnel and to know the better method for tunnel placement, we compared offset guide method versus free hand technique for femoral tunnel placement in 30 cases of arthroscopic ACL reconstruction and assessed the accuracy of placement by post-operative 3D CT-scan by Bernhard hertel quadrant. We found that in free hand method of femoral tunnel drilling, the mean 'h' was 28.62 ± 7.68 (range 15.5 to 42), while mean 't' was 34.86 ± 9 (range 21.5 to 55.5), whereas in offset guide method of femoral tunnel drilling, the mean 'h' was 28.65± 10.19 (range 11.6 to 58), while mean 't' was 31.6 ± 5.02 (range 21.8 to 44.4). P value for difference in t and h by free hand and offset guide method came out to be 0.240 and 0.993 respectively (p value > 0.05), which wasn't significant, concluding that no significant difference was found in femoral tunnel placement by free hand method and offset guide method.

Inderhaug et al found intra-operative fluoroscopy can improve accuracy of tunnel positioning but it is associated with radiation exposure & increases duration of surgery [8]. Celentano et al and Hart et al reported that the anatomical centre of the ACL footprint could not be achieved using a femoral offset guide [9,10]. Tiago Lazzareti Fernandes et al found that 3D-CT protocol is an accurate and reproducible method that can be applied for ACL femoral tunnel or footprint measurement with high reliability [11]. Piefer et al in a systemic review analyzed the accuracy of placement of center of ACL, anatomically and radiologically and found that the centre of ACL foot print was located at mean t value of (proximal to distal) 28.5 (range 23.5 to 43.1) of length and mean h value of 35.2 (range 27.5 to 44.2) of height (h) in relation to Blumensaat line [12] (table 1).

Kim et al compared the efficacy of femoral tunnel position using a femoral offset guide during ACL reconstruction with AM portal, by an expert to a novice surgeon and found that results were almost same by both the surgeons. In their study, study value of t (proximal to distal) was 30.5 ± 4.6 by an expert surgeon and 32.5 ± 3.7 by a novice surgeon and study value of h (anterior to posterior) was 32.6 ± 4.3 for expert surgeon and 31.6 ± 4.6 for novice surgeon, hence they concluded that the femoral offset guide facilitates the accuracy and precision of the femoral tunnel placement, even by a novice surgeon [13]. Saurabh dutt et al found that there was no significant difference in drilling femoral tunnel with free hand or offset aimer, hence they concluded that dependency on aimer devices for femoral tunnel preparation can be reduced [14]. Tantuway et al found that commercially available off set guide technique of the femoral tunnel placement in arthroscopic ACL reconstruction is easy, reliable and reproducible with the foot print at anatomical place on the femoral site [15]. Kawaguchi et al compared the tunnel centre with the centre of the direct femoral attachment site of ACL and found that point in the femur were 32.4% from the proximal margin in the proximal–distal direction and 31.7% from the Blumensaat's line in the anterior-posterior direction [16].

Freehand drilling can give surgeon better manoeuvrability and tunnel position according to anatomy of the patient. The surgeon can confidently drill the tunnel freehand by keeping anatomical footprint and landmark in mind and achieve anatomic tunnel position especially in cases when the knee is small and when the anatomy is distorted, where the offset aimer's method can be faulty and put restraints. In our study, we found that both free hand and offset guide method of femoral tunnel drilling are equally effective and surgeon can drill the tunnel accurately by both the methods by keeping anatomical foot print in mind. In some cases, where knee is distorted, small or deviated from normal anatomy surgeon can prefer free hand or flexible offset guide which provide better manoeuvrability. Both methods have their learning curve and it totally depends on surgeon's experience and requirement of patient. The study is limited by smaller sample size; shorter follow-up and manual method of calculations which can be overcome by a larger sample size with longer duration follow up and automated software method for calculation.

Conclusion

Femoral tunnel positioning by both freehand and offset guide method leads to similar tunnel placement, but both the methods are associated with learning curve. 3D CT-Scan and Bernhard Hertel grid is reliable and reproducible method for evaluating femoral tunnel.

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