INTRODUCTION
Distortion in arthroscopic views can interfere with visualization and measurement of the anatomic ACL insertion site. Parallax errors are created when an angulated lens scope is used from an oblique viewing angle, also “fisheye” distortion is unavoidable in the arthroscopic image.

A 30 degree scope is usually used for ACL reconstruction, but 70 degree scopes through the lateral portal have been described as an alternative technique. Although different combinations of scopes and portals may result in a variety of distortion in the arthroscopic image, quantitative analyses and comparisons of image distortion have not been conducted.

The purpose was to evaluate the arthroscopic image distortion with different sets of scopes and viewing portals. We hypothesized that the medial portal technique with 30 degree scope would show the least distortion in the arthroscopic image.

METHODS
A standard arthroscopic imaging system (Smith & Nephew Endoscopy, Andover, MA) and a sawbones knee arthroscopic simulator were used. A pattern with a uniform grid of dots (IC screen, Tokyo, Japan) was attached on the lateral wall of the femoral intercondylar notch. Images of the lateral wall were captured using five different arthroscopic configurations (three scopes 0º/30º/70º and two viewing portals (medial/lateral); exclude 0º scope through lateral portal; Figure 1)

For each image, the inter-dot distances on three different areas of the lateral wall (e.g. deep, middle and shallow areas) were measured in both horizontal and vertical directions. (Figure 2)

![Figure 1: Experimental setting. a) Overview: The femur was held at 90° of knee flexion by a framework. b) View in the notch: The dot pattern sheet was attached to the lateral wall of the intercondylar notch.](image)

![Figure 2: The image analysis of the arthroscopic picture of the lateral wall. a) Lower half of the lateral wall was divided into three areas, deep, middle and shallow. b) The vertical and horizontal dot separations were measured for the central nine dots.](image)

Three areas of the lateral wall

- Deep
- Middle
- Shallow

Nine dots from each area

1. Horizontal dot separation
2. Vertical dot separation

![Figure 3: Calculation of magnification and distortion ratio.](image)

The magnification in deep and shallow areas was calculated, and the distortion ratio was determined in each area by dividing the horizontal dot separation by the vertical one. (Figure 3)

RESULTS
Similar magnifications were observed for all scope and portal configurations in the deep area. Average magnification in all configurations was 88.4% horizontally and 82.6% vertically. Greater than 100% magnification was found in the shallow area. Lateral portal viewing provided significantly larger magnification errors in the shallow area than medial portal viewing. (Figure 4)

![Figure 4: Magnification in shallow area of five arthroscopic configurations. #: a significant difference among groups, p < 0.05. Distortion ratios of less than 100% (creating “thin” or “wide” images due to non-uniform magnification in the vertical and horizontal directions) were found with both 0º and 30º scope procedures, and more than 100% ratios were with 70º procedures. Distortion ratio error magnitudes through medial portal viewing were similar for the 30º scope (12±7% thinner than actual) and the 70º scope (10±11% wider than actual), which were smaller than through lateral portal viewing. Largest and most variable errors occurred when 70º scope was used through lateral portal viewing, with 20% thinner images in the deep area and 21% wider images in the shallow area. (Figure 5)](image)

![Figure 5: Distortion ratio of five arthroscopic configurations. #: a significant difference among groups, p < 0.05.](image)

DISCUSSION
Medial portal arthroscopic viewing, using either 30º or 70º lenses, provided the least distortion in terms of magnification difference and distortion rate. Largest errors with the greatest variations across different areas of the lateral condyle wall were found with the 70º scope used through the lateral portal viewing. Magnification variation in different areas might cause incorrect graft placement, due to over- or under-estimation of distance. It should be noted that the thinning or widening effect could lead to misunderstanding the shape of the tunnel aperture displayed on the screen. The least distorted and the most consistent image could be provided through medial portal viewing using either a 30º or 70º scope.

SIGNIFICANCE
The image distortion should be carefully considered during knee arthroscopic procedures.

REFERENCES: