



Original Article

Patterns of patellofemoral articular cartilage wear in Japanese cadavers

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ABSTRACT

Introduction: Although we recently reported a detailed description of wear pattern in Caucasians, few studies have investigated severity of wear, and pattern of wear on the patella and femur in Japanese. The purpose of this study was to determine if there is a common joint specific wear pattern in the patellofemoral joint of Japanese cadavers. We further compared the wear pattern and severity between Japanese and US cadavers.

Methods: We examined 46 patellae and matching femurs from 23 Japanese cadavers. The wear location was transcribed to gridded templates, that were compared for frequency, gender, and sidedness of wear. **Results:** Over 60% of the patella showed wear in the odd facet, the middle part of the medial facet, and the medial aspect of the middle part of the lateral facet. The distal femur showed common areas of wear in the posterior aspect of the medial femoral condyle and anterior aspect of the medial femoral condyle. Patella wear may differ with gender as male's wear was more compact. Although the patella and femur wear area was similar between Japanese and US cadavers, femoral wear may be more severe in Japanese cadavers.

Discussion: Patella and femur showed distinct regions of articular cartilage wear. The wear patterns and locations suggest that wear occurs mainly when the knees are moderately and deeply flexed and that these wear patterns may result from common traditional Japanese style of knee positions or activities. © 2017 Anatomical Society of India. Published by Elsevier, a division of RELX India, Pvt. Ltd. All rights reserved.

1. Introduction

Osteoarthritis of the knee (knee OA) is a major public health issue that impairs daily lives.^{1,2} The number of patients with knee OA is suggested to be increasing with advancing age of the Japanese population.³ According to the National Livelihood Survey of the Ministry of Health, Labour and Welfare in Japan, OA is now ranked second among the diseases that cause disabilities requiring support with their daily living activities.⁴

Two of the most common forms of knee OA are combined tibiofemoral and patellofemoral OA, followed by patellofemoral OA.^{5,6} Thus, the patellofemoral joint is a very common site for knee OA⁷ and it can frequently occur in the absence of tibiofemoral joint OA.^{6,8} In addition, patellofemoral OA is believed to develop prior to tibiofemoral OA.⁹

The patellofemoral joint is exposed to forces ranging from 0.5 to 9.7 times body weight during daily activity.¹⁰ Such considerable

force, altered stress due to abnormal alignment, and repetitive movement may result in a specific and common wear pattern of the articular cartilage.¹¹

Although numerous studies have focused on patellofemoral joint kinematics, articular contact forces, articular contact areas, and cartilage thickness of the patellofemoral joint,^{12–14} a limited number of studies have performed extensive macroscopic studies on wear area, severity, and pattern of the patellofemoral joint. We recently reported a detailed description on the location, and severity of wear, gender, and side differences, and specific pattern of wear on the patella and femur in Caucasians.¹¹ In that study, the articular surface of the patella showed more wear in the horizontal area. The distal femur showed common wear in the posterior aspect of the medial, posterior aspect of lateral femoral condyles, and anterior aspect of the medial femoral condyle.

Understanding the anatomy of the patellofemoral joint is a prerequisite to successful management of patients with patellofemoral pathology. In this study, the patellofemoral joints of female and male Japanese cadavers were examined bilaterally. The purpose of this study was to determine if there is a common joint specific wear pattern in the patellofemoral joint of Japanese

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cadavers. We further compared the wear pattern and severity between Japanese and US cadavers.

2. Methods

2.1. Specimens

Twenty-three cadavers, 11 males (age 84.9 ± 8.4 years) and 12 females (age 85.3 ± 5.9 years), randomly obtained from the anatomical board were used to map articular cartilage wear on 46 patellae and 46 distal femurs. Limbs with any noticeable trauma or recent surgery, or hip or knee prosthesis were excluded from this study. Causes of death and occupations varied and were not factors used for selection. Each cadaver received a number and the age and their gender were recorded. Each patella and distal femur was given a specimen number that coincided with the cadaver number and defined as being of the right or left side. This numbering system allowed specimen data to be matched directly to cadaver data for comparison and analysis.

2.2. Measurements

Bilateral patellofemoral joints were opened. The vertical lengths, horizontal lengths of the articular surfaces, and wear perimeters of the patella and distal femur were measured in millimeters using a caliper (Figs. 1 and 2). The vertical length of the patella was the distance measured from the inferior articular limit to the superior articular limit and the horizontal length was the distance measured from the medial articular limit to the lateral articular limit of the articular surface. The horizontal length of the femur was the distance measured from the medial articular limit of the medial condyle to the lateral articular limit of the lateral condyle of the distal femur, and the vertical length was the distance measured from the posterior articular limit of the lateral condyle to the anterior articular limit of the lateral condyle (Fig. 1).

The locations of wear were mapped on a template showing the articular surfaces of these bones. Horizontal zero was the inferior articular limit of the patella and posterior articular limit of the distal femur (Fig. 2). The following four measurements in millimeters were taken on each bone: (1) horizontal length (X1) from the medial end of bone's articular surface to the medial limit of the wear region; (2) horizontal length (X2) from the medial end of bone's articular surface to the lateral limit of the same wear region as in #1; (3) vertical length (Y1) from the inferior end of bone's articular surface to the inferior limit of the wear region in #1; (4) vertical length (Y2) from the inferior end of the bone's articular surface to the superior limit of the wear region in #1. All measurements were performed by the same person. Initially using 10 knee joints, all four measurements were blinded and repeated a

week apart and then compared. The measurements differed by 1–2 mm.

After the horizontal and vertical lengths of the articular surfaces of the patella and distal femur were measured, the average size was calculated (Table 1). The horizontal and vertical lengths of these bones varied between females and males; therefore, the mapping of wear locations for the patella and distal femur had to be adjusted for these variations. To make this adjustment, the overall average horizontal length and vertical length of each bone was made equal to 100%. The template for each bone was then aligned on a percentage scale (Fig. 1). X1, X2, Y1, and Y2 positions were then recalculated as percentages of the overall articular surface of the bone. These points were then plotted on a percentage template to obtain a distribution map of wear (Figs. 3–5).

The magnitude of wear was rated from 0 to IV with 0 = none; I = minimum (soft and swollen cartilage); II = mild (surface cracks, fissure in an area with a diameter less than 1.5 cm); III = moderate (surface cracks, fissure in an area with a diameter greater than 1.5 cm); and IV = severe (exposed subchondral bone) as has been used previously.^{11,15} Rating the wear grade was performed by two people. After one rated the wear grade of each patella and femur, and another with over 35 years of experience performing cadaver dissection rated the same specimens. All wear grades were consistent between the two evaluators.

A *t*-test (two-sided) was used to compare any differences in (1) horizontal and vertical length of the articular surface of the patella and distal femur between females and males, and (2) mean wear area of the patella and femur between females and males. A *t*-test was also used to compare any differences in age and body mass index (BMI) between females and males. The level of significance was $P < 0.05$.

3. Results

3.1. Basic information

There were no significant differences in age and BMI between females and males. In the horizontal and vertical length of the patella and the femur, the measurement of males were significantly larger than for females. The horizontal length of the articular surfaces of the patella was greater than the height. The horizontal length of the articular surfaces of the femur was also greater than the height (Table 1).

3.2. Patella

The central aspect of the odd facet, middle part of the medial facet, and medial aspect of the middle part of the lateral facet showed wear on 61% of specimens for the entire right articular surface of the patella. On the left patella, 60% showed wear in the

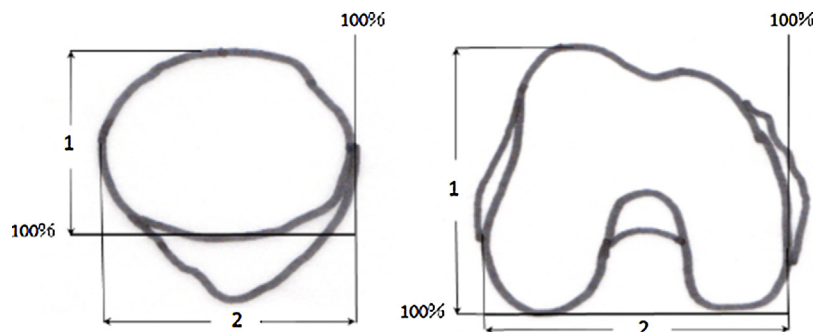


Fig. 1. Diagram illustrating the method used to measure patella and femur dimensions. 1. Vertical length of articular surfaces of each bone, 2. Horizontal length of articular surfaces of each bone.

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