J Shoulder Elbow Surg (2017) ■■, ■■–■■

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

ORIGINAL ARTICLE

Classification of humeral head pathomorphology in primary osteoarthritis: a radiographic and in vivo photographic analysis

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Background: The purpose of this study was to characterize the pathologic changes of the osteoarthritic humeral head.
Methods: The study included 55 patients with primary osteoarthritis who underwent anatomic shoulder arthroplasty. Several radiologic parameters (radiography, magnetic resonance imaging) were assessed. Humeral head deformity in the transverse plane and humeral cartilage erosion in the coronal plane were chosen for photographic measurements from the resected humeral heads.
Results: In the coronal plane, 82% of patients presented with an aspherical humeral head shape with a significantly longer caudal osteophyte. In the transverse plane, 50% of all patients showed a decentered apex. Patients with an aspherical humeral head shape in the transverse plane showed an aspherical humeral head shape in the coronal plane in 94% and a significantly longer osteophyte than patients with spherical humeral head shape, showing a 3-dimensional deformity of the humeral head during progression of primary osteoarthritis. Patients with an osteophyte length between 7 and 12 mm were associated with a glenoid type B2 in 30% and a decentered apex in the transverse plane in 38%. Patients with a humeral osteophyte longer than 13 mm were significantly more frequently associated with a type B2 glenoid (71%; $P < .0001$) and a decentered apex in the transverse plane in 52%.
Conclusion: It seems that the progression of primary osteoarthritis of the glenohumeral joint is characterized by an increasing 3-dimensional deformity of the humeral head related to the glenoid morphology. We therefore propose an extended Samilson-Prieto classification with type A (spherical) and type B (aspherical) and grade I-IV osteophytes.

This study was approved by the Institutional Review Board of the ATOS Clinics Heidelberg and Munich: Study No. 8/14.

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http://dx.doi.org/10.1016/j.jse.2017.07.009

Level of evidence: Anatomy Study; Imaging with Development of Classification System

Keywords: Classification; primary osteoarthritis; modified Samilson-Prieto classification; humeral head deformity; shoulder; glenoid morphology

Over time, primary osteoarthritis exhibits progressive joint deformity with osseous remodeling processes and osteophyte formation. The first pathomorphologic changes of primary osteoarthritis are on the humeral side.[8,18] Although precise anatomy- and morphology-based analyses have been conducted describing these changes,[4,6,8,9,12,16] there is still no specific classification system that pertains to the degree or severity of primary osteoarthritis. Rather, the Samilson-Prieto classification for dislocation arthropathy[13] is often used in daily clinical practice.

The pathologic changes in glenoid morphology have been described in detail by Walch.[15,17] Moreover, classifications have been published regarding glenoid version[10,11] and glenoid inclination,[2] as have analyses pertaining to bone density and glenoid shape.[7,14]

This study set out to radiographically and photographically characterize the pathologic changes of the osteoarthritic humeral head and to ascertain the progression of stages from those data. In doing so, we subject the Samilson-Prieto classification for dislocation arthropathy to validation. Moreover, we test the hypothesis that the humeral changes in the coronal and transverse planes correlate with the changes in glenoid pathomorphology according to Walch.[15]

A final aim of this study was to develop a specific classification system for primary osteoarthritis on the basis of the radiologic and photographic data.

Materials and methods

Our study included 55 consecutive patients (21 women, 34 men) with a mean age of 68.7 years (range, 49-87 years) with primary osteoarthritis who underwent anatomic shoulder arthroplasty. Patients with glenoid deformity type C according to Walch[15] as well as all forms of secondary arthritis and patients with prior shoulder surgery were excluded from this study. All patients underwent preoperative clinical and radiologic examination.

Radiographic evaluation was based on standardized true anterior-posterior (AP) projections and axial radiographs as well as magnetic resonance imaging (MRI) examinations of the shoulder. A digital x-ray apparatus was used, and the images were observed and examined using a diagnostic monitor.

We recorded the following radiologic parameters: by the classification according to Samilson and Prieto,[13] shape of the humeral head in the coronal plane (either spherical or aspherical) and shifts of the apex of sphericity in the transverse plane; and according to Walch, posterior subluxation of the humeral head.[16]

The length of the caudal humeral osteophyte was measured in a cranial to caudal direction in AP projection with the forearm in a neutral position (Fig. 1, *A*). The arthritis was then classified using the system presented by Samilson and Prieto,[13] with the following categories: grade 1, <3 mm, mild osteoarthritis; grade 2, 3-6 mm, moderate osteoarthritis; and grade 3, ≥7 mm, severe osteoarthritis.

The humeral head was categorized as either spherical or aspherical in the coronal plane. Classification was performed by AP

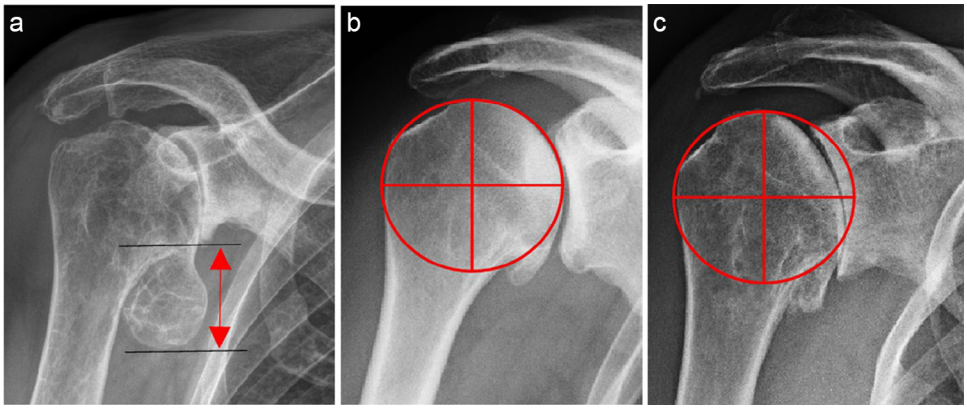

Figure 1 Humeral head measurements in the coronal plane on anterior-posterior radiographs. (**A**) Measuring the caudal humeral osteophyte on anterior-posterior image. (**B**) Spherical head shape with projection of the best-fitting circle onto the cortical boundaries of the humeral head. (**C**) Aspherical head shape. Cortical boundaries on the articular side of the humeral head are not within the confines of the best-fitting circle.