SCIENTIFIC ARTICLE

Correlation of Clinical Disease Severity to Radiographic Thumb Osteoarthritis Index

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Purpose To determine if a slight modification of the 1987 Eaton-Glickel staging and interpreting 4 standardized radiographs for trapeziometacarpal (TMC) osteoarthritis (OA) improved analysis, to determine if a quantifiable index measurement from a single Robert (pronated anteroposterior) view enhanced reproducibility, and to examine whether improved radiographic staging correlated to clinically relevant disease and thus support validity.

Methods We analyzed 4 thumb radiographs (posteroanterior, lateral, Robert, and stress views) in 60 consecutive subjects representing an adult population spectrum of asymptomatic to advanced disease. Two experienced hand surgeons (A.L.L. and A.P.C.W.), 1 chief resident (A.J.B.), and 1 medical student (J.M.M.) performed the analysis on each subject's radiographs. We analyzed all 4 radiographs for Eaton and modified Eaton staging and then later analyzed only the Robert view for the thumb osteoarthritis (ThOA) index measurement. The radiographs were randomized and reread a week later for each classification at separate times. Surgically excised trapeziums from 20/60 subjects were inspected for first metacarpal surface disease and correlated to the 3 classifications.

Results All 3 staging classifications demonstrated high reproducibility, with the intraclass correlation coefficient averaging 0.73 for the Eaton, 0.83 for the modified Eaton, and 0.95 for the ThOA index. Articular wear and metacarpal surface eburnation correlated highest to the ThOA index, with advanced disease 1.55 or greater correlating to Eaton III/IV and modified Eaton stage 3/4 in a linear relationship.

Conclusions The ThOA index based on a Robert view provided a measurable alternative to Eaton staging and correlated to severity of surgically relevant thumb TMC OA.

Clinical relevance A simple reproducible radiographic measurement may enhance TMC OA classification and provide a reliable means to predict clinical disease. *(J Hand Surg Am. 2015;40(3):474–482. Copyright © 2015 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Diagnostic II.

Key words Eaton classification, interrelater reliability, radiographic index, thumb carpometacarpal arthritis, trapeziometacarpal arthritis.

THE PREVALENCE OF TRAPEZIOMETACARPAL (TMC) osteoarthritis (OA) and its myriad surgical operations underscore its importance as a major musculoskeletal disease.[1–3] Symptoms may not correspond to radiographic findings, and a patient's perceived disability typically drives surgical intervention. The orthopedic and hand literature commonly cites Eaton radiographic classification in

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TABLE 1. Eaton-Littler and Eaton-Glickel Classification Schemes

Stage	1973 Eaton-Littler[4]	1987 Eaton-Glickel[5]
X-ray images	Multiple, variable	Lateral
0	—	—
I	Slight joint widening, less than one-third subluxation, normal articular contours	Slight joint widening
II	Small bone/calcific fragments < 2 mm volar or dorsal, one-third or greater subluxation	Slight joint narrowing, minimal subchondral sclerosis, joint debris (osteophytes or loose bodies) < 2 mm
III	Greater than one-third subluxation, fragments > 2 mm volar and/or dorsal, slight joint narrowing	Marked narrowing/obliteration joint space, cystic changes, sclerotic bone, varying degrees of dorsal subluxation, joint debris > 2 mm
IV	Advanced changes applicable to rheumatoid arthritis, major subluxation, very narrow joint space, cystic sclerotic subchondral bone, lipping and osteophyte trapezial formation, erosion dorsoradial facet	Stage III deterioration + scaphotrapezial joint narrowed with sclerosis and cystic changes

clinical series.[4–7] This severity staging is derived from the Kellgren-Lawrence classification,[8,9] a widely used arthritis staging system in the rheumatology and orthopedic literature. The Eaton-Littler radiographic staging reported in 1973[4] correlated surgical results of 1 procedure to TMC joint radiographic and surgical joint degeneration and subluxation. Eaton and Glickel's revised 1987 surgical indications classification[5] included stage IV scaphotrapezial arthritis and complete TMC joint deterioration, while eliminating subluxation as defining criteria (Table 1).

Although often a surgeon's guidepost for decision making, the Eaton staging possesses fair to moderate intraobserver reliability (kappa range, 0.54–0.66) and poor to fair interobserver reliability (kappa range, 0.37–0.53).[6,10–12] The descriptive Eaton-Littler[4] and Eaton-Glickel[5] classifications, the criteria differences between stages, and confusion regarding which classification is specified potentially contribute to this phenomenon. Criteria include joint space narrowing, peripheral bone formation, and subluxation. The 1987 adaptation changes 1973 joint narrowing and joint destruction staging: "slight" joint narrowing changes from stage III to stage II disease and joint space destruction changes from stage IV to stage III (Table 1). The 2 classifications do not delineate between "slight" or "markedly" narrowed joints or define joint destruction degree. Bony "fragments"[4] or "joint debris"[5] are not distinguished as osteophytes or loose bodies/ossicles. In the Kellgren-Lawrence classification,[9] osteophytes (grade I) and ossicles (grade 2) indicate progression of disease, although size is not specifically measured. Subluxation, in both its presence and its degree, is variably reported in the Eaton classifications (Table 1). Subluxation is a defining criterion in stages I to III in the 1973 scheme[4] but is identified only in stage III with the 1987 scheme.[5] Literature analyzing Eaton classification utility is inconsistent regarding which classification to use. A 2011 article referenced the 1973 classification including subluxation.[11] A 2002 article cited both schemes,[10] and a 2004 article used the 1987 classification.[6] Recent evidence indicates subluxation is a normal phenomenon in both men and women.[13,14] Although 1 lateral x-ray view forms the basis for the 1987 Eaton-Glickel classification,[5] in practice, many surgeons today use additional views to stage disease. As a result, lack of agreement in defining radiographic disease possibly contributes to the poor correlation of symptoms to severity and the definition of severity itself.

We hypothesized that a reproducible, quantifiable radiographic scheme would correlate to clinically relevant disease. To test this hypothesis, we proposed a slight modification to the 1987 Eaton-Glickel grading system[5] encompassing multiple views with a goal to improve accuracy and, secondarily, to create a new measurable index based on a single, reproducible radiographic view of the TMC joint. We then posed 3 questions. Does a standardized set of radiographs representing multiple views of the thumb provide better accuracy when using our modified Eaton classification? Is an index measuring the height and width of the trapezium on the Robert (pronated anteroposterior) view[15–19] (Figs. 1, 2) reproducible among various examiners? Does this index correlate to surgical disease severity?