ORIGINAL ARTICLE

# Radiographic cervical spine osteoarthritis progression rates: a longitudinal assessment

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**Abstract** Relative to other sites, the cervical spine has received little attention in the osteoarthritis (OA) literature. Using data from a longitudinal study, we provide age-specific progression rates of radiographic cervical spine OA, by gender. Data from cohort subjects (ages 40+) from the Clearwater Osteoarthritis Study were analyzed ($N = 707$). All study subjects' demonstrated radiographic cervical spine OA at baseline (2+). Lateral cervical spine radiographs were taken biennially. The study outcome was radiographic disease progression. A grade increase of 1, or more, by the Lawrence and Kellgren ordinal scale was considered progression. Incidence rates were calculated as per 100 person-years of observation. We show that the progression rates for cervical spine OA increase with age. For all ages combined, men demonstrated higher rates of progression compared with women. However, among subjects in their forties and fifties, women were more likely to experience worsening of their disease when compared with men. Progression rates were similar for men and women in their sixties (8.2 and 8.0, respectively). Among subjects in their seventies, men demonstrated a significantly higher rate of progression compared with women (12.5 and 8.6, respectively). As the baby-boomer population continues to increase, cervical spine OA progression assessment can be a useful tool for health-care resource planning. Cervical spine OA research offers an abundance of opportunities. Instability as a precursor to the development of cervical spine OA warrants further research. Epidemiological studies addressing demographic differences (e.g., gender, age) in the incidence of cervical spine OA will contribute to the current knowledge base.

## Introduction

During the past decade, the field of osteoarthritis (OA) research has grown rapidly with molecular, clinical and epidemiological studies. The knee, hip and hand have been the sites of primary focus. Relative to other sites, the cervical spine has received little attention in the published OA literature. Cervical spine OA (spondylosis) is a generalized disease process potentially affecting all levels of the cervical spine. It encompasses a sequence of degenerative changes in the intervertebral discs, osteophytosis of the vertebral bodies, hypertrophy of the facets and laminar arches and ligamentous and segmental instability. A subset of spondylosis patients develops neurologic sequelae. These may be progressive. Resultant radiculopathic and myelopathic symptoms can lead to significant disabilities. Related studies have reported characteristics of cervical OA [1–7]. In this brief report, we provide age-specific progression rates of radiographic cervical spine OA, by gender, from a cohort of 707 subjects.

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## Subjects and methods

The Clearwater Osteoarthritis Study (COS), initiated by The Arthritis Research Institute of America (ARIA) in 1988, is an ongoing community-based, prospective cohort study with over 3,700 subjects (ages 40+ years). The research objective of the COS is to identify the major risk factors for the development and progression of OA and to differentiate risk factors for localized and generalized primary OA. Data are collected from study subjects biennially, and includes demographic, historical, clinical and radiological information. COS volunteer recruitment is conducted using a variety of methods, including: invitational letters, television and radio announcements, newspaper articles publicizing the COS study, articles posted in community organizations' bulletins, as well as seminars held at community clubs and organizations.

### Data collection

During the initial visit, a detailed study description is given to the subject, followed by a screening questionnaire to determine eligibility. Exclusion criteria are individuals with self-reported rheumatoid arthritis or variants (lupus erythematosus, ankylosing spondylitis, etc.), gout, disabling neuralgic disease, confined to a wheelchair or mentally incompetent. Once eligibility is established, informed consent is obtained prior to data collection. All eligible, voluntary subjects complete the COS History Questionnaire and undergo a physical examination. Using standardized exposure techniques a licensed X-ray technician takes radiographs of the knees, hands, feet and the cervical spine (lateral view). Study participants are re-evaluated biennially, updating the history questionnaire and the clinical (physical examination and X-rays) information. Research was conducted in compliance with the Helsinki Declaration.

### Radiographic measurement

Radiographs are interpreted by a board-certified radiologist, blinded to the individual study subjects' status. Using the Kellgren & Lawrence ordinal scale [8] as a guide, cervical spine OA cases are defined at baseline as those subjects with grades 2 or higher for degenerative changes in any of the cervical facet joints, while those with grades 0 or 1 are considered disease free.

The study outcome was radiographic cervical spine OA progression. Among those with radiographic cervical spine OA at study baseline, an increase to grades 3 or 4 was defined as radiographic cervical spine OA progression. Subjects were required to have a grade 2 or 3 at baseline. Specifically, subjects with progression were defined as those who experienced an increase from grade 2 or 3 at baseline to any higher grade during the follow-up period.

Quality control measures were taken to ensure the validity of the radiographic assessments. Every tenth subject's assembled radiographs were independently interpreted by a non-affiliated radiologist (blinded to initial reading results), allowing for quantification of the inter-observer variability. This was calculated using the kappa coefficient, measuring the extent of reader agreement above that due to chance alone [9]. Inter-reader reliability by a second radiologist reflected 93% agreement ($\kappa = 0.85$).

### Statistics

As the COS study has a dynamic entry cohort and subjects are followed for differing lengths of time (i.e., subject's withdraw, die, relocate, etc.), a person-years denominator was used. The observation period was the interval between study entry time and either (1) radiographic cervical spine OA progression, (2) study withdrawal or (3) data censoring. When calculating incidence density rates, the numerator is the number of subjects who experience cervical spine progression. The denominator is the sum of the years for which subjects were observed disease free. As disease (progression) risk does not remain constant over time, rates are reported by age group. All rates are annual incidence rates (per 100 person-years of observation), reported by gender and by age group.

## Results

Table 1 shows the baseline demographic characteristics of our cohort sample. The mean follow-up time was 5.8 (SD = 4.2) years. Our cohort shows that the progression rates for radiographic cervical spine OA increase with age (Table 2; Fig. 1). For all ages combined, men demonstrated higher rates of radiographic progression compared with women. However, among subjects in their forties and fifties, women were more likely to experience worsening of

**Table 1** Baseline characteristics of subjects with radiographic cervical spine osteoarthritis, $N = 707$

|                      | $N$  | (%)    |
| -------------------- | ---- | ------ |
| Gender (female)      | 472  | (66.8) |
| Gender (male)        | 235  | (33.2) |
| Cervical OA score = 2 | 498  | (70.4) |
| Cervical OA score = 3 | 209  | (29.6) |
|                      | Mean | (SD)   |
| Age (years)          | 66.8 | (8.9)  |
| BMI                  | 26.8 | (4.9)  |

*BMI* body mass index (kg/m$^2$)

**Table 2** Gender-specific progression rates of radiographic cervical spine osteoarthritis, by age

|  | N | Cases | Follow-up Time (years) | Rate[a] |
|---|---|---|---|---|
| **Men** | | | | |
| 40–49 | 10 | 3 | 82 | 3.7 |
| 50–59 | 29 | 12 | 225 | 5.3 |
| 60–69 | 87 | 40 | 490 | 8.2 |
| 70–79 | 95 | 56 | 447 | 12.5 |
| 80+ | 14 | 5 | 54 | 9.3 |
| Total | 235 | 116 | 1,298 | 8.9 |
| **Women** | | | | |
| 40–49 | 21 | 10 | 180 | 5.6 |
| 50–59 | 84 | 48 | 628 | 7.6 |
| 60–69 | 180 | 88 | 1,096 | 8.0 |
| 70–79 | 167 | 70 | 814 | 8.6 |
| 80+ | 20 | 7 | 75 | 9.3 |
| Total | 472 | 223 | 2,794 | 8.0 |

*N* number of subjects with cervical spine osteoarthritis at study baseline; cases, number of subjects who experience worsening (progression) of their cervical spine osteoarthritis during the study observation period; follow-up time, number of person-years of observation

For example, among men ages 70–79 years, for every 100 person-years of follow-up time, we saw 12.5 cases of radiographic cervical spine OA progression

[a] Rates are per 100 person-years of observation
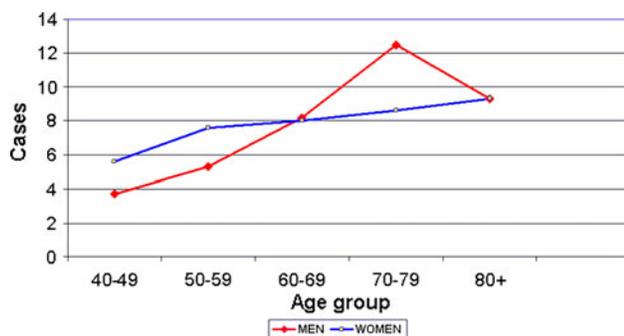


**Fig. 1** Gender-specific incidence rates for progression of radiographic cervical spine osteoarthritis, by age (*N* = 707)

their disease compared with men. Progression rates were quite similar for men and women in their sixties (8.2 and 8.0, respectively). Among subjects in their seventies, men demonstrated a significantly higher rate of progression compared with women in the same age group (12.5 and 8.6, respectively).

## Discussion

As the baby-boomer population continues to increase, the assessment of radiographic cervical spine OA progression can be a useful tool for health-care resource planning. Treatment usually is conservative, with non-steroidal antiinflammatory drugs, physical modalities and lifestyle modifications most commonly used [10–12]. Surgery occasionally is performed. Many of the treatment modalities for cervical spondylosis have not been subjected to rigorous, controlled trials. Surgery is advocated for cervical radiculopathy in patients who have intractable pain, progressive symptoms or weakness that fails to improve with conservative therapy. Surgical indications for cervical spine myelopathy remain controversial, but most clinicians recommend operative therapy over conservative therapy for moderate to severe myelopathy. In view of this, knowledge related to the rate of cervical spine progression may assist the clinician in patients' conservative and surgical management.

This cohorts study's prospective design is able to clearly establish the presence of baseline cervical spine OA, and the subsequent progression of the same. Although the COS utilizes a community-based sample, one would not expect disease progression to be influenced by biases inherent to some designs.

The importance of cervical OA as a contributing factor in diagnosing a wide range of possible secondary "rheumatic" problems cannot be overlooked in a clinical setting. In addition to contributing to neck pain [13, 14], and upper and lower back pain [15], cervical OA may be a significant contributing factor to both upper and lower extremity diagnoses. Upper extremity problems include arm pain [14, 15], shoulder pain [13, 14], adhesive capsilitis [16], tennis elbow [17], medial epicondylitis [18], wrist pain [17, 19] and carpal tunnel syndrome [17, 20]. Lower extremity problems may include leg weakness/dysfunction [15] and may even contribute to knee problems [21]. Even symptoms that may not typically be associated with orthopedic problems may result from cervical spondylitis including dysphagia (problems swallowing) [13, 18], dyspnea (difficulty breathing) [13] and angina pectoris or angina-like pain [22].

The field of cervical spine OA offers an abundance of research opportunities. Instability as a precursor to the development of cervical spine OA warrants further research. Epidemiological studies addressing demographic differences (e.g., gender, age) in the incidence of cervical spine OA will contribute to the current knowledge base. Longitudinal studies better establishing risk factors for cervical spine OA include traumatic injury, instability, familial factors, loss of cervical lordosis, low vitamin D levels, menopause (as opposed to age), obesity, pain level, disability, exercise and occupation.

**Conflict of interest statement** The authors declare that they have no conflict of interest.

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