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Frequency of radiologic procedures in patients with rheumatoid arthritis

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Abstract

Background—Patients with rheumatoid arthritis (RA) undergo radiologic investigations for disease and comorbidity evaluation. The actual use of radiologic imaging in RA is unknown.

Methods—Using the Rochester Epidemiology Project medical record linkage system, adult patients from previously assembled population-based cohorts of Olmsted County, Minnesota residents who fulfilled 1987 ACR criteria for RA in 1988-2007, and comparator subjects without RA of similar age and sex were studied. Data on all radiologic procedures performed were collected.

Results—The study included 650 patients with RA and 650 patients without RA. Patients with RA had significantly more radiographs of the chest (RR: 1.33, 95% CI: 1.28-1.38), upper extremity (RR: 2.97, 95% CI: 2.80-3.17), lower extremity (RR: 2.05, 95% CI: 1.94-2.16), spine (RR: 1.46, 95% CI: 1.35-1.59), and hip, pelvis or sacroiliac joints (RR: 1.14, 95% CI: 1.03-1.26), as well as bone radionuclide (RR: 1.90, 95% CI: 1.50-2.44) and DXA imaging (RR: 1.77, 95% CI: 1.59-1.98) compared to patients without RA. Among patients with RA, having RF+ was associated with an increased likelihood of undergoing radiologic procedures (RR: 1.05, 95% CI: 1.02, 1.07). Women with RA underwent more imaging procedures than men (RR: 1.20 95% CI: 1.16-1.23).

Conclusions—Patients with RA undergo more radiologic procedures than patients without RA. Among patients with RA, women and patients with positive RF have more radiologic procedures. The utilization of radiography is likely a reflection of overall disease burden; the role of various imaging modalities is in flux and will likely change in ensuing years.

Keywords

Radiographs; resource utilization; rheumatoid arthritis

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Introduction

Patients with rheumatoid arthritis (RA) have characteristic radiologic changes that have historically aided in the diagnosis of the disease as well as in assessment of disease progression. [1] Although radiologic findings have only a limited role in the initial diagnosis of RA because typical findings occur in already advanced disease, radiographs and other imaging studies continue to be an important part of the initial evaluation and follow up of patients with RA. [2,3,4,5]

Radiologic imaging is used in disease diagnosis and clinical follow-up to follow treatment effects longitudinally. [6] Conventional radiography has been used for this purpose, and it has been suggested that hand/wrist radiographs be obtained every 2 years for patients with RA. [7] However, it is unclear how often radiographs are actually obtained in the longitudinal management of patients with RA.

In addition to the aforementioned tests to assess for disease burden, patients with RA undergo imaging as part of routine evaluation for comorbidities as well in the setting of preventive services (e.g., mammograms, dual-energy x-ray absorptiometry (DXA) scan for osteoporosis). There may be increased utilization of health care system resources, including some diagnostic imaging studies, in patients with RA.

In this study, we evaluated the use of radiologic procedures in patients with RA. We sought for the first time to determine whether the frequency of radiologic procedures is different in patients with RA compared to patients without RA.

Methods

Using the resources of the Rochester Epidemiology Project medical record linkage system, adult patients from a previously assembled population-based cohort of Olmsted County, Minnesota residents who fulfilled 1987 American College of Rheumatology criteria for RA in 1988-2007, as well as a previously identified comparison cohort of subjects without RA of similar age and sex were studied. [8] Patients were followed from RA incidence (or a corresponding index date for non-RA subjects) to date of death, migration from Olmsted County, or April 1, 2013. Data on all radiologic procedures performed on these patients were retrieved electronically from billing data from Olmsted County medical providers including Mayo Clinic and Olmsted Medical Center and their affiliated hospitals. Current procedural terminology codes were used to identify the types and dates of radiologic procedures for each subject. This study was approved by the institutional review boards at the Mayo Clinical and the Olmsted Medical Center.

The total number of radiologic procedures, the total person-years (py) of follow-up, the number and rates of radiologic images by anatomic sites, and the number and rate of DXA and radionuclide bone imaging were described for each cohort. Comparisons of person-year rates of use of radiologic procedures by type and site were performed using Poisson methods.

In order to describe adherence to the guidelines of hand/wrist radiographs every 2 years for patients with RA, a separate analysis was performed. For this, follow-up was divided into the following intervals: 90 days before RA incidence to 1 year after RA incidence (designated as the baseline time period), two year intervals thereafter (e.g., 1-3 years after RA incidence, 3-5 years after RA incidence, etc). For each time period, cumulative incidence of hand/wrist radiographs was estimated with adjustment for the competing risk of death. For this analysis, patients were considered to have an event on the date of the first hand/wrist radiographs in each time period. Multiple hand/wrist radiographs in the same patient during the same time period were not counted. Therefore, the cumulative incidence at the end of each time period is a measure of the proportion of patients who meet the guideline of having hand/wrist radiographs during each 2-year period.

Results

The study population included 650 patients with RA and 650 subjects without RA. The mean age of the patients was 55.8 years and 69% were female. A total of 27,088 radiologic procedures were performed among patients with RA and 21006 among non-RA subjects, during a total of 7358 person-years of follow-up for the RA and 7597 person-years of follow-up for the non-RA subjects (RR: 1.32, 95% CI: 1.30-1.35). These radiologic procedures included conventional radiographs of elbow, shoulder, wrist, hand, hip, knee, ankle, feet, chest and spine as well as computed tomography (CT) and magnetic resonance imaging (MRI) of the head, upper and lower extremities, radionuclide bone imaging, mammograms and DXA scanning.

Patients with RA had significantly more conventional chest radiographs compared to those patients without RA (RR: 1.33, 95% CI: 1.28-1.38). This was also the case for upper extremity (RR: 2.97, 95% CI: 2.80-3.17), lower extremity (RR: 2.05, 95% CI: 1.94-2.16), bone radionuclide (RR: 1.90, 95% CI: 1.50-2.44) and dual-energy X-ray absorptiometry (DXA) imaging (RR: 1.77, 95% CI: 1.59-1.98).

Patients with RA also had significantly more conventional radiographs of the spine (RR: 1.46, 95% CI: 1.35-1.59), hip, pelvis and sacroiliac joints (RR: 1.14, 95% CI: 1.03-1.26). (Table 1) Among patients with RA, having a positive rheumatoid factor (RF+) was associated with an increased likelihood of undergoing radiologic procedures (RR: 1.05, 95% CI: 1.02, 1.07).

Similarly, among the RA patients, women underwent more imaging procedures than men (RR: 1.20 95% CI: 1.16-1.23). This was also true and the results were nearly identical for patients without RA (RR: 1.20; 95% CI: 1.17-1.24). Among patients without RA, the use of radiologic procedures overall has increased somewhat in recent years (RR: 1.08 95% CI: 1.05-1.12 for subjects with index date in 1998-2007 compared to 1988-1997), most likely due increases in the use of advanced imaging (CT, MRI imaging). However, among patents with RA, we did not find a significant change in the rate of radiologic procedures overall among patients with RA diagnosed in 1998-2007 compared to those diagnosed in 1988-1997 (RR: 0.98; 95% CI: 0.96, 1.01).

CT/MRI imaging of upper and lower extremities increased in patients with RA diagnosed in 1998-2007 compared to those diagnosed in 1988-1997 (RR for upper extremity: 4.53; 95% CI: 2.69, 8.62; RR for lower extremity: 2.22; 95% CI 1.57, 3.25). While CT/MRI imaging of upper and lower extremities also increased for subjects without RA whose index date was in 1998-2007 compared to those with index date in 1988-1997 (RR for upper extremity: 2.99; 95% CI: 1.70, 5.96; RR for lower extremity: 3.09; 95% CI 1.91, 5.47), the rate of CT/MRI imaging of upper and lower extremities among patients with RA was significantly increased compared to those without RA during the entire study period (RR for upper extremity: 1.66; 95% CI: 1.27, 2.19; RR for lower extremity: 1.76; 95% CI 1.41, 2.20).

Hand/wrist radiographs were obtained in 57% of patients within 1 year after initial RA diagnosis, but during the 1-3 years after diagnosis, only 42% had undergone hand radiographs, and only 32% had hand radiographs during 3-5 years after the diagnosis. Beyond 5 years of the initial diagnosis, the percentage of patients with RA who had routine hand radiographs every two years plateaued around 28%. A subgroup analysis demonstrated that the cumulative incidence of patients with hand/wrist radiographs within 1 year after RA diagnosis was significantly higher in patients who were RF+ (62%) than in those with negative RF (45%; $p<0.001$). This difference persisted during 1-3 years after RA diagnosis (46% in RF+ vs. 34% in RF-; $p=0.003$), 3-5 years after RA diagnosis (37% in RF+ vs. 23% in RF-; $p<0.001$), and 5-7 years after RA diagnosis and (34% in RF+ vs. 25% in RF-; $p=0.046$). The cumulative incidence of radiologic procedures was no longer significant at 7-9 years after RA diagnosis (30% in RF+ vs. 23% in RF-; $p=0.15$) or beyond (28% in RF+ vs. 26% in RF- at 9-11 years after RA diagnosis; $p=0.62$). (Figure 1)

Female patients with RA had more radiologic procedures than their male counterparts (RR: 1.20; 95% CI: 1.16, 1.23). Similarly, DXA scans were more frequently obtained in women than in men (RR: 2.25; 95% CI: 1.89, 2.71). Mammography was only performed in female patients and was less frequently obtained in women with RA than women without RA (RR: 0.93; 95% CI: 0.88, 0.99).

To account for the increased number of diagnostic modalities in the last decade we conducted a small subgroup analysis encompassing the periods of 1988-1997 and 1998-2007 and found no significant difference in the number of radiologic studies between these time periods.

Discussion

The aim of this study was to assess the use of radiologic imaging in patients with RA compared to subjects without RA. We found that patients with RA, especially women and those with positive RF, undergo more radiologic procedures, than patients without RA. The rate of radiologic procedures has not changed in recent years. While biennial hand radiographs are obtained more often in patients with RF+, we found that clinicians are not consistently following suggestions regarding obtaining baseline and followup radiographs. .

Conventional radiography has traditionally been used to document characteristic changes of RA including bone erosions and joint space narrowing. Indeed, the latter two radiologic

findings help quantify joint damage progression in scoring systems such as the Sharp score and its modified versions. [9] This tool is commonly utilized in clinical trials for assessment of efficacy of therapeutic interventions. In addition to hand radiographs, patients with RA are most likely to undergo imaging of the lower limbs as well as spine and pelvis.

Usage of advanced imaging (CT/MRI) of upper and lower extremity is higher in patients with RA than those without RA, and has increased in recent decades. The frequency of bone radionucleotide tests was also higher in patients with RA. However, among female patients, mammograms were performed less frequently among patients with RA than those without RA. Perhaps patients with RA receive more specialist care and less preventive services. This population also had DXA scans more often than non-RA patients, probably because of awareness that their disease and corticosteroid use increase the risk for osteopenia and osteoporosis. Patients with RF+ had more radiologic studies than RF-negative individuals. The presence of RF correlates with disease severity, and may account for the reason that patients with RF+ had greater numbers of imaging studies as a reflection of more aggressive disease and need for close monitoring.

Female patients with RA underwent more radiologic procedures. Hand/wrist radiographs were obtained more often in women, which may reflect disease severity and that women have more joint surgeries than men. [10] As well, mammograms and bone density scans were included in the overall analysis; both are obtained more frequently in women.

The American College of Rheumatology recommends obtaining hands and feet radiographs at the initial diagnosis of RA. They and others have suggested periodic reevaluation thereafter. [6,7] We found that 4 years after the initial diagnosis only about 35% of patients had regular radiographs at 2 year intervals. In this subgroup of patients, RF positivity was also a predictor of regular hand/wrist x-rays at 2-year interval until 6 years from initial diagnosis. After that time no significant difference was noted compared to patients who do not have RF.

Strengths of this study include the virtually complete ascertainment of all radiologic procedures performed on this population over a very long period. Limitations include the fact that indications for radiologic imaging could not be adequately assessed. As well, radiographs done prior to incidence of RA were not captured; however the two cohorts were matched on date of RA incidence so that the follow up periods were comparable. While we studied procedures with ionizing radiation, we did not attempt to formally assess overall radiation exposure or disease progression in the hand radiographs for technical reasons. Because not all ultrasound procedures done in the context of joint evaluations were consistently recorded until recently, we do not have full information about ultrasound use.

Conclusion

Patients with RA, especially those with positive RF, undergo significantly more radiologic procedures than individuals without RA, particularly of the hands/wrist and feet. At the same time, clinicians may find their value limited judging by the relatively low rates of routine radiologic follow up of these target joints. The utilization of radiography is likely a

reflection of overall disease burden; the role of various imaging modalities is in flux and will likely change in ensuing years.

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Key Messages

1. Patients with rheumatoid arthritis (RA) undergo significantly more radiographic procedures than patient without RA.
2. Patients with positive rheumatoid factor have more radiographs than patients without rheumatoid factor
3. Hand radiographs are obtained at irregular intervals; only 35% have these biennially through 6 years.

Figure 1.

Percentage of patients with RA who had at least one hand/wrist x-ray according to years since RA diagnosis by RF positivity (circles= RF negative, squares=RF positive). Asterisks under the x-axis indicate statistically significant differences between groups (p<0.05).

Number of different radiologic procedures in 650 patients with and 650 subjects without rheumatoid arthritis

Table 1

Category	Patients with RA			Patients without RA			Rate Ratio (95% CI)
	Scans (n)	Rate per 100 py	Scans (n)	Rate per 100 py	Scans (n)	Rate per 100 py	
Conventional radiograph hand/wrist	2908	39.8	650	8.6			4.62 (4.25, 5.04)
Conventional radiograph ankle/foot	2237	30.6	809	10.7			2.86 (2.64, 3.10)
All upper extremity imaging*	3843	52.7	1335	17.7			2.97 (2.80, 3.17)
CT/MRI only	137	1.9	85	1.1			1.66 (1.27, 2.19)
All lower extremity imaging*	3808	52.2	1910	25.5			2.05 (1.94, 2.16)
CT/MRI only	213	2.9	124	1.6			1.76 (1.41, 2.20)
All chest radiographs*	6155	84.7	4777	63.5			1.33 (1.28, 1.38)
DXA	843	11.5	490	6.5			1.77 (1.59, 1.98)
All radionuclide bone**	183	2.5	99	1.3			1.90 (1.50, 2.44)

CI = confidence interval; CT= computed tomography; MRI=magnetic resonance imaging; DXA = Dual-energy X-ray absorptiometry; n = number; py = person years; RA= rheumatoid arthritis;

* includes computed tomography and magnetic resonance imaging and conventional radiography

** includes sintigraphy and indium and positron emission tomography