Radiographic Recognition of Cervical Instability in Rheumatoid Arthritis

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ABSTRACT

Rheumatoid arthritis is an autoimmune arthritis that has a predilection for small peripheral joints and the cervical spine. Although most patients commonly present with peripheral joint complaints, an estimable 43-50% of patients with cervical spine involvement are asymptomatic. The craniocervical junction is the most common cervical spine site of involvement and the atlanto-axial and the subaxial cervical spine may also be involved. Cervical instability is often diagnosed in patients undergoing unrelated procedures who are essentially asymptomatic and hence routine screening and radiological assessment of cervical instability in these patient is of importance. Complications related to cervical spine involvement are variable and may include cord compression, discitis, pathological fractures of the odontoid or erosions. Instability patterns of the cervical spine may occur and include atlanto-axial instability, basilar invagination and subaxial subluxation (8), with atlanto-axial instability being the most common.

Keywords: Cervical instability, radiographs, rheumatoid arthritis, spine

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INTRODUCTION

Rheumatoid arthritis represents one of the most common inflammatory arthritis presented to the orthopaedic surgeon. The disease affects several joints, inclusive of the cervical spine. The peripheral orthopaedic manifestations are often painful, disabling and of great cosmetic concern to the patient. As such, the vast majority of presentations to the orthopaedic surgeon are in relation to peripheral joint affliction. The cervical spine involvement, although often existent, is rarely the reason for appearance (1, 2). There is however significant risk of morbidity and mortality from undiagnosed cervical spine involvement. Thus, attention to this should take precedence. A case of an asymptomatic cervical instability in a patient presented to the orthopaedic outpatient department for management of knee arthritis is investigated below.

CASE REPORT

This is the case of a 46 year old female who is known to have had rheumatoid arthritis for the last thirty years controlled on plaquenil and methotrexate. The patient was referred to our outpatient department (OPD) for further management of bilateral hip disease. On presentation to the OPD, her only complaint was of bilateral hip pain. Review of plain radiographs of both hips revealed Kellgren and Lawrence Stage 4 disease bilaterally. Her neurological examination was normal. In preparation for her arthroplasty, plain cervical spine radiographs were ordered, which revealed an increase in the atlanto-dens interval on lateral and flexion cervical spine radiographs with reduction on extension views (Fig. 1).

There was neither rotatory instability nor evidence of basilar invagination. Stabilization of the cervical spine was thus undertaken prior to arthroplasy. Posterior instrumentation and lateral mass fusion was performed with no intraoperative or postoperative complications.

DISCUSSION

The first description of rheumatoid arthritis affecting the cervical spine was made by Garrod in 1890 (3). In his series the rate of spine involvement was a mere 35%, however more recent studies estimate a prevalence of 80% (3, 4). While cervical spine involvement remains a distant second to the peripheral joints of the hands and feet for the region most commonly afflicted by rheumatoid arthritis, complications related to cervical spine involvement carries a significant risk of morbidity and mortality. A mortality of approximately 10% secondary to cord compression is seen in the rheumatoid population (5). Approximately 11-58% of patients have a lifetime neurological impairment risk. The development of neurological deficits in the patient with rheumatoid arthritis not only results in significant morbidity but a mortality rate as high as 50% is conferred within the first year after the development of myelopathy (6). Furthermore, a large number of these patients may be asymptomatic, as per index case, ranging from 43-50% (2, 7).

Cervical instability is often diagnosed in patients undergoing unrelated procedures, as seen in the case presentation. Collins et al. reported a 61% rate of cervical instability in patients undergoing hip and knee arthroplasty (2). Routine screening and radiological assessment of cervical instability in these patients is thus of paramount importance. Instability pattern of the cervical spine varies and may take the form of atlanto-axial instability, basilar invagination and subaxial subluxation (8). Atlanto-axial instability is the most common manifestation followed by basilar invagination and subaxial subluxation (9). Other manifestations within the cervical spine includes discitis and pathological fractures of the odontoid or erosions. Atlanto-axial instability occurs as a result of the disruption of the atlanto-axial articulations. These comprise of a paired lateral articulation between the lateral masses of C1 and C2 and a median articulation between the dens and the posterior aspect of the anterior arch of C1 (10). This pivotal joint is held in place

by purely ligamentous connection. Such ligaments include the transverse ligament, alar ligament and the apical ligaments (10). Atlanto-axial dislocation may occur in an anterior, posterior, lateral or rotatory manner.

Anterior atlanto-axial dislocation is the most frequent variant occurring in over 75% of cases of atlanto-axial dislocation (10). It requires the disruption of the transverse ligament before translation can take place to a maximum of 5mm (11). Disruption of the alar ligaments allows for translation up to 10mm and a disruption of all ligaments results in translation up to 12mm (11). Radiographically anterior atlanto-axial subluxation is defined as an anterior atlanto-dens interval (AADI) greater than 3mm. This interval is measured from the posterior surface of the anterior arch of the atlas to the anterior aspect of the dens (Fig. 3). Variations in this measurement however correlate poorly with the clinical development of neurological symptoms.

Boden et al. demonstrated a greater correlation of the posterior atlanto-dens interval (PADI) with neurological deficits (12). The measurement is taken from the anterior aspect of the posterior arch of the atlas to the posterior aspect of the dens (Fig. 4). Neurological abnormalities were seen in all patients with a PADI of less than 14mm (12).

Asymmetric involvement of the lateral atlanto-axial articulation results in lateral atlanto-axial dislocation. This phenomenon is seen in 9-20% of cases of atlanto-axial dislocation (13, 14). The lateral cervical spine radiographs will appear misleadingly normal and diagnosis requires an open mouth view where a translation of greater than 2mm of the lateral mass of C1 on C2 with tilting is diagnostic. Destruction of the dens results in elimination of the restraint to posterior translation resulting in posterior atlanto-axial dislocation (PAAD). With this translation the space available for the cord is rapidly decreased and neurological impairment is often seen (15).

In evaluating the cervical spine for atlanto-axial instability, it is important to account for all variations. Lateral plain radiographs in neutral will fail to detect 48% of cases (16). It is therefore of utmost importance that lateral radiographs in neutral, flexion and extension are taken along with the open mouth view (Fig. 5). Destruction of the atlanto-axial and atlanto-occipital joint results in cranial migration of the odontoid towards, and into the foramen magnum. The destructing pannus along with the odontoid process decreases the space available for the cord and may compress the brainstem with its possible sequelae. It is the most feared and sinister of the cervical instability.

There are several radiographic methods of determining basilar invagination including McGregor's method, Rannawat method, Redlund-Johnell method and Kauppi method. The McGregor method utilizes McGregors Line, which is a horizontal line connecting the hard palate and occiput [Fig. 6] (17). Basilar invagination is defined as cranial migration of the odontoid 4.5mm above this line (17). Determination via this method is sometimes difficult because of erosions of the odontoid tip and osteoporosis, which often occurs in the rheumatoid patient. In an effort to overcome these difficulties, the Redlund-Johnell utilizes the mid-point of the base of the odontoid as the reference point, instead of the tip, and measures the distance from McGregor's Line [Fig. 7] (18). The normal range is greater than 34mm and 29mm for males and females respectively.

On the other hand, the Rannawat method utilizes the landmarks of the pedicle of C2 and the anterior and posterior arch of C1. The vertical distance of the C2 pedicle from the horizontal line connecting the anterior and posterior arch of C1 is measured (Fig. 8). In the normal patient, reference ranges are greater than 15mm and 13mm for males and females respectively.

Comparatively, the Kauppi method utilizes the settling of C1 on C2 (19). The vertical distance of the anterior and posterior arch from the pedicle of C2 is observed and different grades assigned:

(1) Grade 1 – Normal

(2) Grade 2 – Pedicle of C2 abuts the inferior aspect of arch of C1

(3) Grade 3 – Pedicle of C2 reaches the midpoint of the arch of C1

(4) Grade 4 – Pedicle of C2 reaches the superior margin of the arch of C1

Subaxial subluxation represents a translation of 3.5mm or more of one vertebra on the adjacent. Progressive translation ultimately decreases the space available for the cord and ultimately may result in neurological compromise. A minimal diameter of 14mm is required at all levels of the cord to prevent cord impingement. The subluxation is often multiple and the result on space available for the cord is not simply additive. The cervical height index (CHI) is a very sensitive indicator of risk for cord impingement. It is calculated by dividing the distance from the centre of the pedicle of C2, to the midpoint of the inferior border of C7, by the horizontal distance of the midpoint of the pedicle of C2, to the spinous process of C2.

Timing of surgical intervention in the rheumatoid spine remains undefined. That which is clearly defined however are the long term mortality once neurological deficit occurs, and the unlikelihood of recovery from neurological deficits once they have occurred. Therefore, early detection of cervical instability prior to onset of disability is key to decrease morbidity and mortality in these patients.

CONCLUSION

Cervical spine instability is rarely the reason for index presentation to the orthopaedic surgeon. It however has the greatest risk of morbidity and mortality compared to the peripheral orthopaedic manifestation of the disease. As a result, identifying and addressing cervical instability in patients presented for other complaints is of paramount importance. The instability can often be diagnosed with appropriate plain cervical radiographs.

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Fig. 1: Lateral cervical spine radiographs in neutral, flexion and extension showing increase in the anterior atlanto-dens interval on lateral and flexion views with reduction on extension views.

Fig. 2: Lateral cervical spine radiographs in neutral, flexion and extension showing stable fixation on all views.

Fig. 3: Lateral cervical spine radiographs in neutral and flexion showing measurement of anterior atlanto-dens interval (AADI).

Fig. 4: Lateral cervical spine radiographs in neutral showing measurement of posterior atlanto-dens interval (PADI).

Fig. 5: Lateral cervical spine radiographs in neutral, flexion and extension showing variations in anterior atlanto-dens interval (AADI).

Fig. 6: Lateral cervical spine radiographs showing determination of basilar invagination by distance of dens above McGregor's Line.

Fig. 7: Lateral cervical spine radiographs showing determination of basilar invagination by Redlund-Johnell method.

Fig. 8: Lateral cervical spine radiographs showing determination of basilar invagination by Rannawat method.