ORIGINAL RESEARCH ARTICLE

Role of CT and MRI in Evaluation of Acquired Disorders of Craniovertebral Junction in a Rural based Medical College

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A B S T R A C T

Introduction: The craniovertebral junction is a complex articulation between occiput, atlas and axis and supporting ligaments. It encloses the soft tissue structures of the cervicomedullary junction which includes medulla, spinal cord and lower cranial nerves. It is a potential site of variety of radiologic diagnosis and misdiagnosis. In this study we have reviewed acquired abnormalities of the craniovertebral junction and evaluate usefulness of Magnetic Resonance Imaging and Computed Tomography.

Material and methods: A prospective study was carried on 44 patients clinically suspected to have craniovertebral junction abnormalities of acquired origin. Computed Tomography and Magnetic Resonance Imaging were performed in all patients and the imaging features in both the modalities were recorded, analyzed and studied.

Results: On completion of the study, analysis of the obtained radiological data was done. Traumatic injuries were the most common acquired craniovertebral junction abnormality. Odontoid fracture predominantly type II was the commonest injury noted. Tuberculosis of craniovertebral junction showing bone erosion and enhancing soft tissue component was the next common abnormality observed. Rheumatoid arthritis showing pannus formation and bone erosion was the other abnormality observed in this study.

Conclusion: Magnetic Resonance Imaging is the imaging mode of choice for evaluation of the craniovertebral junction for a variety of reasons like its superior morphologic demonstration of soft tissue structures with multiplanar capabilities. However a Multislice, Spiral or Helical, 3-D reconstructed Computed Tomography image is as good and sometimes is better for clear-cut understanding of bony abnormalities at craniovertebral junction.

Key words: Cervicomedullary Junction, Odontoid Fracture, Tuberculosis, Rheumatoid Arthritis.

INTRODUCTION

The occiput, atlas, axis and supporting ligaments collectively form the craniovertebral junction(CVJ). It encloses the soft tissue structures of the cervicomedullary junction (medulla, spinal cord, and lower cranial nerves) and is visible in magnetic resonance(MR) imaging studies of the brain. It is a potential site of variety of radiologic diagnosis and misdiagnosis.

Acquired CVJ abnormalities

i)Traumatic

Injuries to the craniocervical junction are common, and they are among the few skeletal injuries that carry a high likelihood of death. The familiarity with the normal anatomic relationships of this region of the spine and recognition of the critical consequences of injured structures are deciding factors in successful management of these injuries. The stability given by ligamentous structures in this region surpasses the intrinsic bony stability making it vulnerable to injury because of the large lever-arm induced rostrally by the cranium and the relative freedom of movement of the craniocervical junction.

An attempt to evaluate six injury types will be made, which often coexist: (i) Occipital condyle fractures, (ii) Craniocervical dissociation, (iii) Fractures of the atlas, (iv) C1–C2 ligamentous instability, (v) Odontoid fractures, and (vi) Traumatic spondylolistheses (hangman's fractures) of C2.

ii) Infections

Infectious process involving the craniocervical junction are unusual. Any infection that can involve the spine or bone generally may affect the craniocervical junction. There is no organism with special affinity towards CVJ.

iii) Inflammatory

Rheumatoid Arthritis/Juvenile Rheumatoid Arthritis are chronic inflammatory disorder characterized by synovial joint involvement and has been shown to affect CV region in 40% of cases. Seronegative arthropathy(associated with HLA-B27), Ankylosing spondylitis, reactive arthritis and enteropathic arthropathies typically result in stiffening or fusion of the involved joints, the associated arthritis can

cause severe erosive changes in the ligaments and associated joints. When this occurs in occipetocervical region significant instability can result.

iv) Neoplasm

Neoplasms involving the craniocervical junction are unusual. Metastatic malignancies such as carcinoma of the breast, lung prostate, kidney and thyroid in adults; and neuroblastoma, Ewings tumor, leukemia, hepatoma and retinoblastoma in children are most common. Primary malignancies involving the craniocervical junction are rare with multiple myeloma at the top of the list and others include chordoma, eosinophilic granuloma, osteoblastoma etc. Benign tumors are very rare. The radiologic features of neoplasms in the craniocervical junction are basically the same elsewhere in the spine.[1]

In this study we have reviewed some of the acquired abnormalities that are be found in the CVJ. The purpose of this study was to make a humble effort in evaluation of these abnormalities on the CT and MRI and to enlighten ourselves about this well understood but still confusing anatomical complex.

MATERIAL AND METHODS

A prospective study was carried on 44 patients referred to the Department of Radiodiagnosis, Adichunchanagiri Institute of Medical Sciences, B G Nagara, from August 2016 to December 2017. Ethical clearance was taken from ethical committee of the college.

A sample of 44 patients referred from out patient department and emergency department were included in this study. Patients with congenital and syndromic disorders of CVJ and those contraindicated for CT and MRI were excluded from the study.

The CT Scans were performed on a 16 slice GE BRIVO 385 CT machine.

The MRI scans were performed on a 1.5T GE Machine with axial, coronal and sagittal planes obtained using multiple sequences in various imaging planes.

Imaging characteristics in CT and MRI were recorded. Final diagnosis was noted and the results were analyzed and studied.

STATISTICAL ANALYSIS

Descriptive statistics like mean and percentages were used to calculate results.

RESULTS

On completion of this study 44 cases of CVJ abnormalities were studied, an analysis of the obtained radiological data was done. We obtained following results, which were tabulated for an easier understanding.

Among the traumatic cases, the maximum number of patients came to us in 3rd decade. Predominance of males with a ratio of 9:1 was obtained, which may be attributed as males are more prone to trauma as they are more outgoing and used for heavy work. The most common injury was odontoid fracture (80%) which is followed by fracture of Atlas with an incidence of 20%. The most common MR finding was odontoid fracture(80%) in the form osseous injury which is followed by cord edema(30%) in the form of neural injury (Table 1). The most common CT findings was odontoid fracture(80%) which is followed by fracture involving lower

	Number	Percentage
Odontoid Fractures	21	80%
Fracture of atlas	5	20%
Fracture of axis	2	7%
Occipital Condyle Fracture	1	3%
Atlanto-occipital dislocation	2	8%
AtlantoAxial Dislocation (AAD)	2	8%
Cord compression	5	20%
Cord edema	8	30%
Absent Flow void in vertebral artery	03	11%

Table-1: MRI findings in trauma

	Number	Percentage
Odontoid Fractures	21	80%
Fracture of atlas	5	20%
Fracture of axis	2	7%
Occipital Condyle Fracture	1	3%
Atlanto-occipital dislocation	2	8%
AtlantoAxial Dislocation (AAD)	2	8%
Other spine injuries	8	30%

Table-2: CT findings in trauma

	No	Percentage
Bone erosion	4	50%
Soft tissue component	4	50%
AAD	4	50%
Epidural component	2	25%
Contrast Enhancement	4	50%

Table-3: CT findings in tuberculosis

	No	Percentage
Bone erosion	4	50%
Soft tissue component	4	50%
Atlanto Axial dislocation	4	50%
Epidural component	2	25%
Transverse ligament breach	2	25%
Transverse ligament thickening	2	25%
Contrast enhancement	6	75%
CMJ compression	2	25%
Cord edema	2	25%

Table-4: MR findings in tuberculosis

	No	Percentage
Bone erosion	6	75%
Atlanto Axial Subluxation	4	50%

Table-5: CT findings in Rheumatoid arthritis

	No	Percentage
Bone erosion	6	75%
Pannus	8	100%
Ligament thickening	6	75%
Atlanto Axial Subluxation	4	50%
CMJ compression	6	75%

Table-6: MR findings in Rheumatoid arthritis

Figure-1: MRI showing Type II odontoid fracture

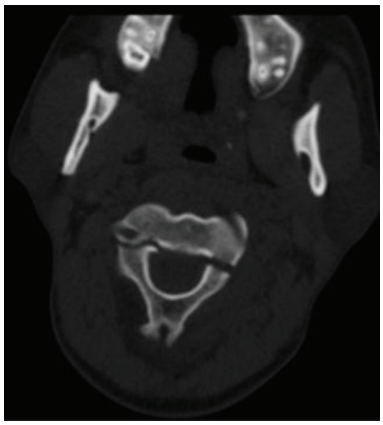

Figure-2: CT showing Type I Hangman's fracture

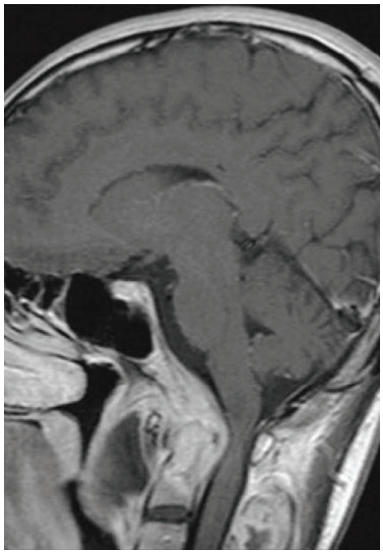

Figure-3: Contrast MRI retropharyngeal abscess with C2 involvment in Tuberculosis

cervical spine(30%) (Table 2). The most common odontoid fracture was Type II with 55.55% followed by type III (22.2%).

Among cases of tuberculosis, the most common age group involved were adults from 40 and above. The youngest was 2 year old and the oldest was 65 years old. The most common CT findings were bone erosion, soft tissue component and Atlantoaxial dislocation(AAD) (Table 3)**.** The most common MR finding was contrast enhancement in the soft tissue and CVJ ligaments followed by bone erosion and AAD (Table 4). The grading of CVJ tuberculosis is done according to Lifeso grading based on CT. There were four cases of both grade I and Grade III.

Among cases of rheumatoid arthritis, the most common age group involved were adults more than 60yrs and above. The most common CT findings were bone erosions and atlanto axial subluxation (Table 5). The most common MR findings were pannus formation followed by bone erosions (Table 6). The most common location of pannus formation was retrodental space followed by predental space.

DISCUSSION

Acquired CVJ abnormalities

Injuries of the Craniovertebral Junction

Injuries to the craniocervical junction are common, and they are among the few skeletal injuries that carry a high likelihood of death.[2-4] They are often difficult to diagnose on initial imaging studies. Injuries to the upper cervical spine that disrupt its structural integrity carry a high likelihood of death due to the vital functions of the nearby neurovascular structures.

In our study the most common finding was odontoid fracture (Figure 1) followed by fracture of atlas. In the study by Lee Et al [5], the most common injury is fracture of atlas (Figure 2) followed by Odontoid fracture. Fracture of atlas with odontoid fracture was the most common combination of injury seen in our study which correlated with the study by Lee Et al[5] and Dickman Et al.[6] Type II odontoid fracture was the most common type of odontoid fracture in our study which correlated with study by CR Clark Et al[7] and Anderson Et al.[8]

Craniovertebral Junction Tuberculosis (TB)

Primary CVJ TB is rare. It occurs secondary to pulmonary TB, cervical/mediastinal lymph nodes or elsewhere in the body. The infection reach the synovial lining of the occipito-atlanto-axial joints by lymphatic route by spreading in retrograde direction.[9] The disease then spreads to ligaments causing ligamentous destruction and instability. Subsequently it extends to the surrounding bone causing destruction and collapse.[10]

On the basis of CT of CVJ, Lifeso[11] graded CVJ TB into the following grades:

Grade 1- increased prevertebral shadow

Grade 2- AAD and early bony changes

Grade 3- AAD, Gross destruction of bone and pathological fracture

In our study, there were four cases of both grade I and grade III.

MRI especially with gadolinium contrast enhancement better delineates the soft tissue abnormalities. Prevertebral, paravertebral and epidural collections/granulation tissue are better delineated by MRI. It had been seen that early changes of bone involvement can be picked up on MRI as intensity changes.[12] Spinal cord abnormalities were graded by Krishnan *et al*.[12] into 3 grades as follows:

Grade 1- no displacement of theca and no evidence of compression

Grade 2- displacement of theca but no evidence of

compression

Grade 3- compression of the cord with or without degenerative changes such as syrinx or myelomalacia.

The most common MR finding in our study was contrast enhancement in the soft tissue and CVJ ligaments followed by bone erosion and AAD (Figure 3) which correlates with study by Krishnan A Et al[12].

Rheumatoid arthritis

Rheumatoid arthritis is a chronic, inflammatory disorder characterised by symmetric polyarthritis involving multiple joints. The cervical spine can be involved in 17%–86% of patients with rheumatoid arthritis. It can involve the supra-axial or subaxial spine with the craniovertebral junction being most often affected.[13] In rheumatoid Arthritis there is an immunologic dysfunction that leads to hypertrophy of the synovial tissue with pannus formation which causes erosion of the articular cartilage and subchondral bone.[14,15]

Three patterns of cervical spine involvement have been described:

1) Atlantoaxial subluxation (65%),
2) Atlantoaxial impaction (20%-25%), and
3) Subaxial subluxation (10%-15%).

The most common MR findings were pannus formation followed by bone erosions followed by atlantoaxial subluxation which correlated with study by Bundschuh Et al.[16] The most common location of pannus formation was retrodental space followed by predental space which nearly correlated with study by Bundschuh et al. [16]

Miscellaneous inflammatory conditions affecting the craniovertebral junction.

The seronegative spondyloarthropathies are a group of related disorders that cause inflammation and ossification of the entheses or sites of ligamentous/tendinous insertion into bone. They commonly affect the spine and sacroiliac joints, as well as the peripheral joints, rheumatoid factor is generally not detected in the serum of patients with these diseses, but there is an association with specific genetic marker, HLA-B27, Ankylosing spondylitis(AS), psoriatic arthropathy, reactive arthritis (reiter's syndrome). The associated arthritis can cause severe erosive changes in the ligaments and associated arthritis can cause severe erosive changes in the ligaments and associated joints.[17,18] No cases of seronegative arthritis affecting CVJ was seen in our study.

CONCLUSION

CVJ is a most challenging region for radiologic investigation because of the complex osseous relationships of the CVJ with multiple neurovascular structures of the cervicomedullary junction. Review of these cases confirms that MRI is the imaging mode of choice for evaluation of the CVJ for a variety of reasons like its superior morphologic demonstration of soft tissue structures with multiplanar capabilities. The contrast between different tissues can be manipulated by altering the applied pulse sequence and thus better visualization and resolution of required tissue can be achieved. Prior to surgery, topographical relationships of structural lesions is better evaluated by the multiplanar facility of MRI. However a Multislice, Spiral or Helical, 3-D reconstructed CT image is as good and sometimes is better for clear-cut understanding of bony abnormalities at CVJ especially for unskilled one.

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