The Cranio-cervical junction, Hypermobility & Upright M.R.I.

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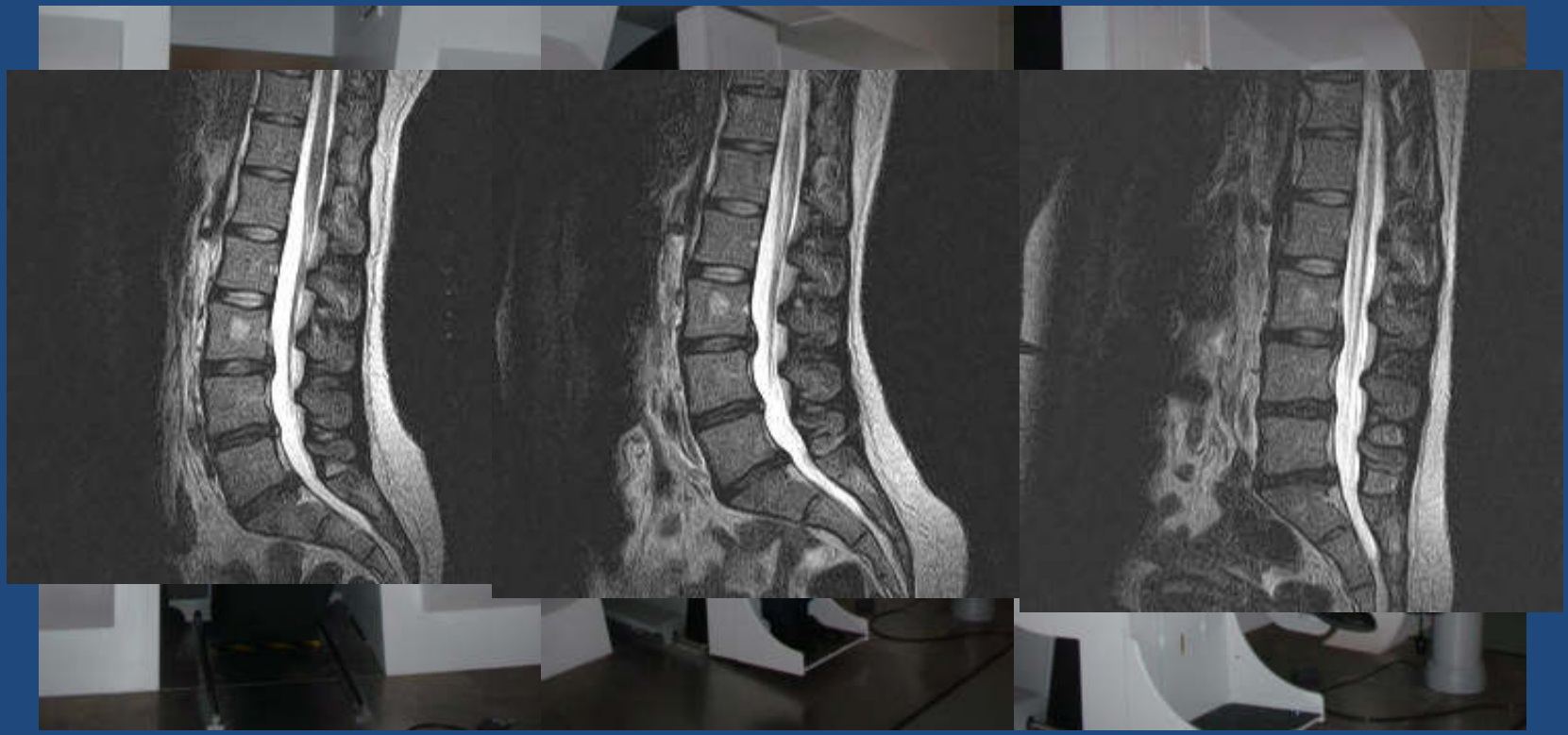
UPRIGHT M.R.I.

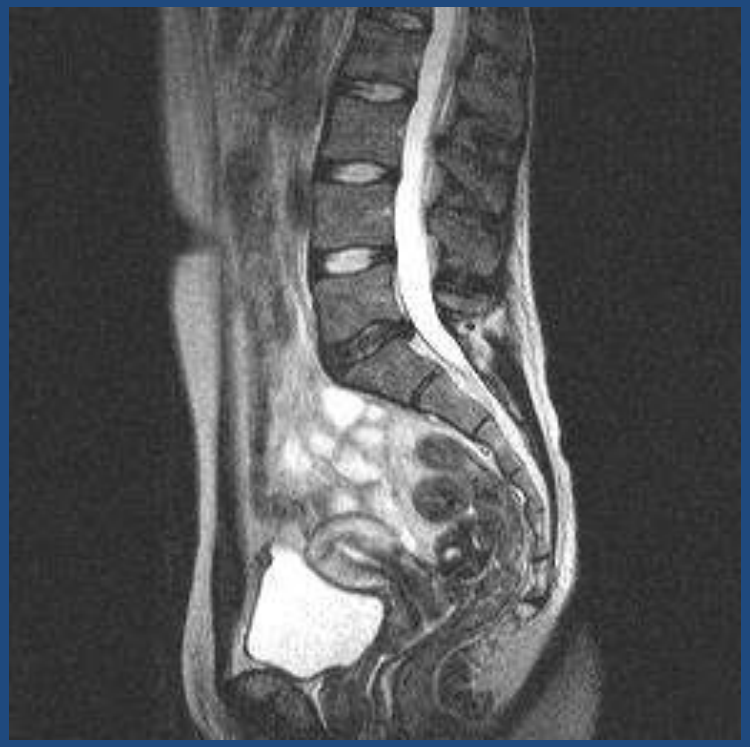
Why do we persist in scanning the spine lying down?

Upright MRI

Upright MRI allows patients to simply walk in and be scanned while lying supine, standing up or sitting down.



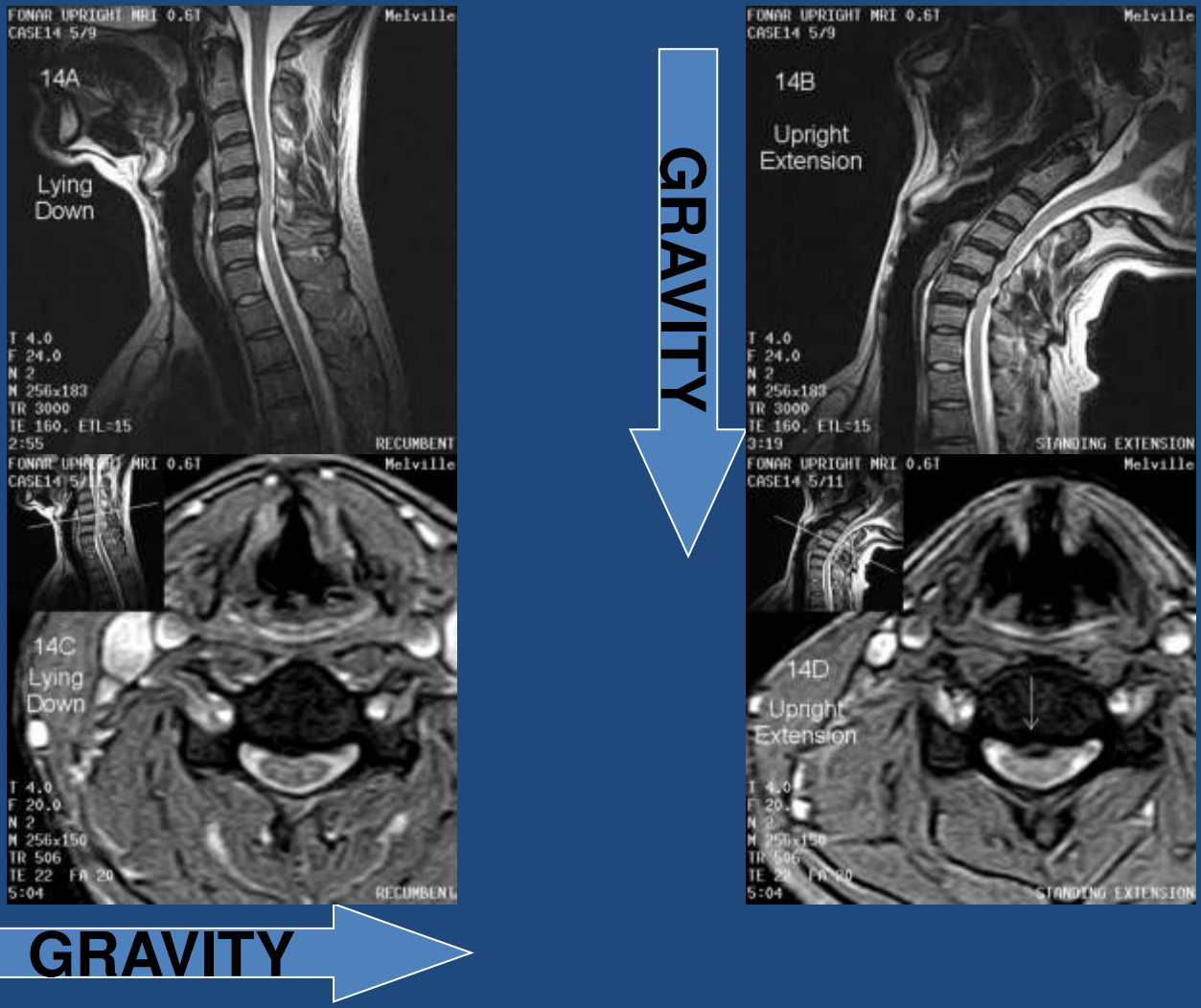
UPRIGHT M.R.I.



GRAVITY

GRAVITY

UPRIGHT M.R.I.


FONAR UPRIGHT MRI 0.6T
Melville
CASE14 5/9
14A
Lying Down
RECUMBENT
14B
Upright Extension
STANDING EXTENSION
14C
Lying Down
14D
Upright Extension
GRAVITY
GRAVITY

Cerebellar Tonsils

GRAVITY

GRAVITY

Case Study

Case courtesy of J.P. Elsig, M.D.
Zurich, Switzerland

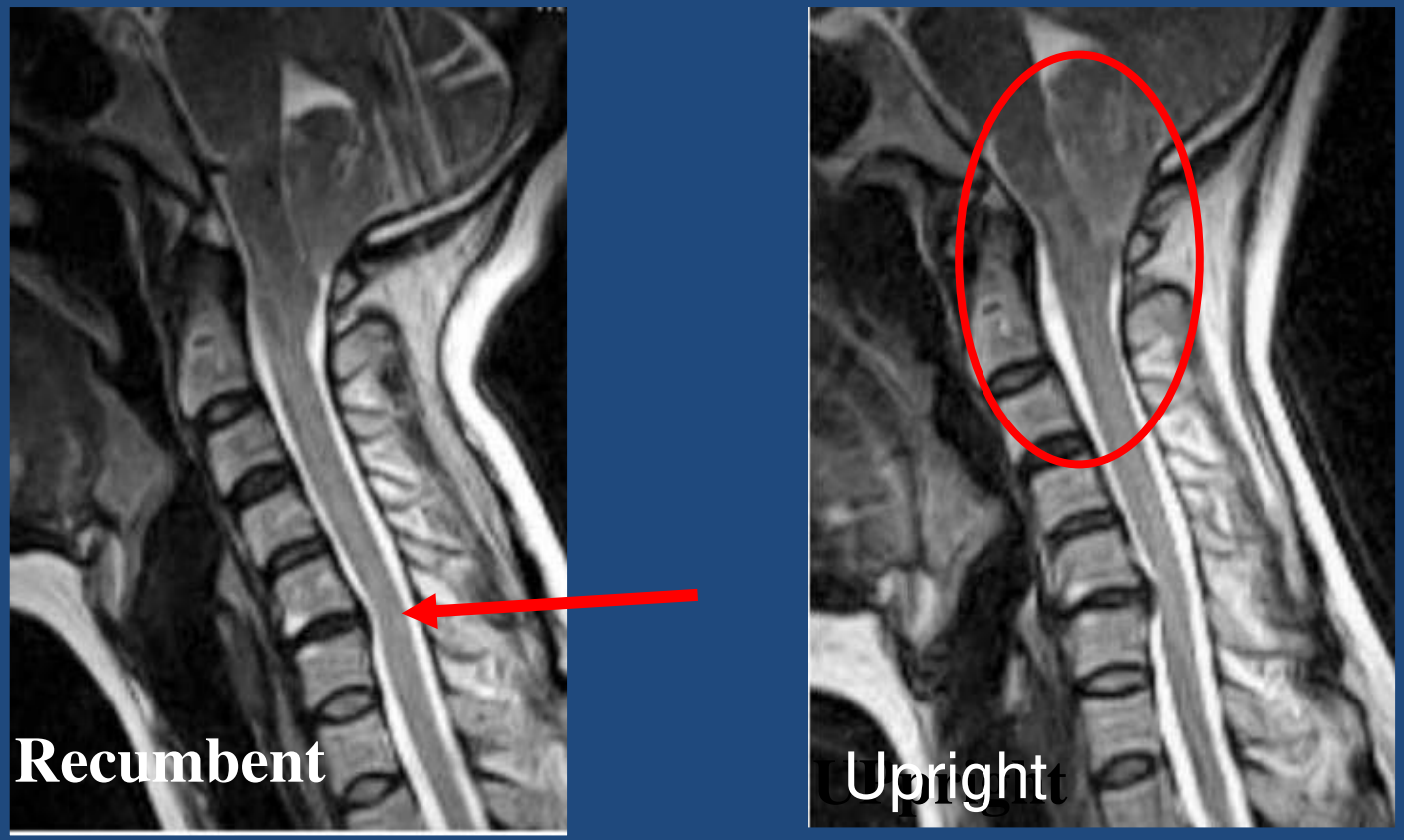
A 50-year-old woman had been suffering for years from neck pain. A prior recumbent MRI had shown a C5-6 disc degeneration with a posterior bulge and a moderate segmental kyphosis.

Despite repeated attempts with conservative treatment, the patient's symptoms worsened and were marked by the onset of:

- ***transient paresthesia***
- ***transient loss of muscle tone in the legs***
- ***drop attacks***

Which could **not** be explained by the disc bulge.

The recumbent cervical MRI shows a C5-6 disc bulge in a patient with neck pain which sometimes radiates to the arms



The **UPRIGHT** MRI shows a position-related downward herniation (Chiari I malformation) with compression of the brain stem. This correlates with the additional complaints of dizziness and occasional drop attacks when bending forward.

Cervical Whiplash and Chiari : Coincidence, Correlation or Causation ?

A case-control study of Cerebellar Tonsillar Ectopia and Cervical Spine trauma

Freeman M D,	Forensic Epidemiologist
Rosa S,	Chiropractor
Harshfield D,	Radiologist
Smith F W,	Radiologist
Bennett R,	Rheumatologist
Olson T,	Anatomist
Centeno C,	Physiatrist
Kornel E,	Neurosurgeon
Heffez D,	Neurosurgeon
Nystrom A,	
Kohles S,	Biomechanist

Brain Injury July 2010; 24(7-8): 988-994

Method

MRI studies of the cervical spine and base of the skull from 1200 consecutive neck pain patients 18 years and older presenting to 4 different outpatient radiology centers over a 3 year period were reviewed.

Half of the scans (600) were acquired from a facility with a 0.6T upright open MRI scanner.

The other half (600) were obtained from a facility with a 0.7T conventional recumbent open MRI scanner.

The scans were further subdivided into 2 subgroups;

Half were from patients with neck pain following a road traffic accident.

Half were from patients with no recent history of trauma.

The resulting 4 groups comprise 300 scans each

Recumbent Non-trauma	(RNT),
Upright Non-trauma	(UNT),
Recumbent Trauma	(RT),
Upright Trauma	(UT).

The images were interpreted by two radiologists, blinded with regard to the clinical history and scanner type.

The scans were categorized by the level of the lowest point of the cerebellar tonsils relative to the basion-opisthion line

Basion – Opsthion Line

Tonsil position - grading criteria

Tonsil position	Position relative to B-OL
+3	>5 mm above
+2	3 mm to <5 mm above
+1	1 mm to <3 mm above
0	<1 mm above to <1 mm below
-1	1 mm to <3 mm below
-2	3 mm to <5 mm below
-3	>5 mm below

Results

Average tonsil station

The relative frequency of tonsil at and below the foramen magnum for each group and by gender.

Analysis of variance (ANOVA) with a Tukey pairwise comparison was used to evaluate for significant differences in average station among the subgroups and genders.

Chi-square goodness of fit test used for evaluation of the proportional differences between the groups.

A Kappa statistic was used to assess the level of agreement between the two radiologists. (Analyse-It, Leeds UK).

Results

Of the 1200 scans 5 were considered uninterpretable for tonsil station by one or the other of the radiologists.

All 5 were in the recumbent trauma group.

Amongst the remaining 1195 subjects

The average age was
41.5 and 39.7 years in the trauma group

57.4 and 54.0 years in the non-trauma group (recumbent and upright, respectively).

The majority of subjects were female in all groups.

Results

There was good agreement between the two radiologist readers regarding tonsil station (kappa range 0.85 to 0.95).

Both injury status and scan type (recumbent vs. upright) were associated with significant differences in the average tonsil station ($p = <0.0001$).

Results - Mean tonsil station

Non-trauma group tonsils were below the B-O Line in

5.7% recumbent 5.3% upright

Trauma group the tonsils were below the B-OL in

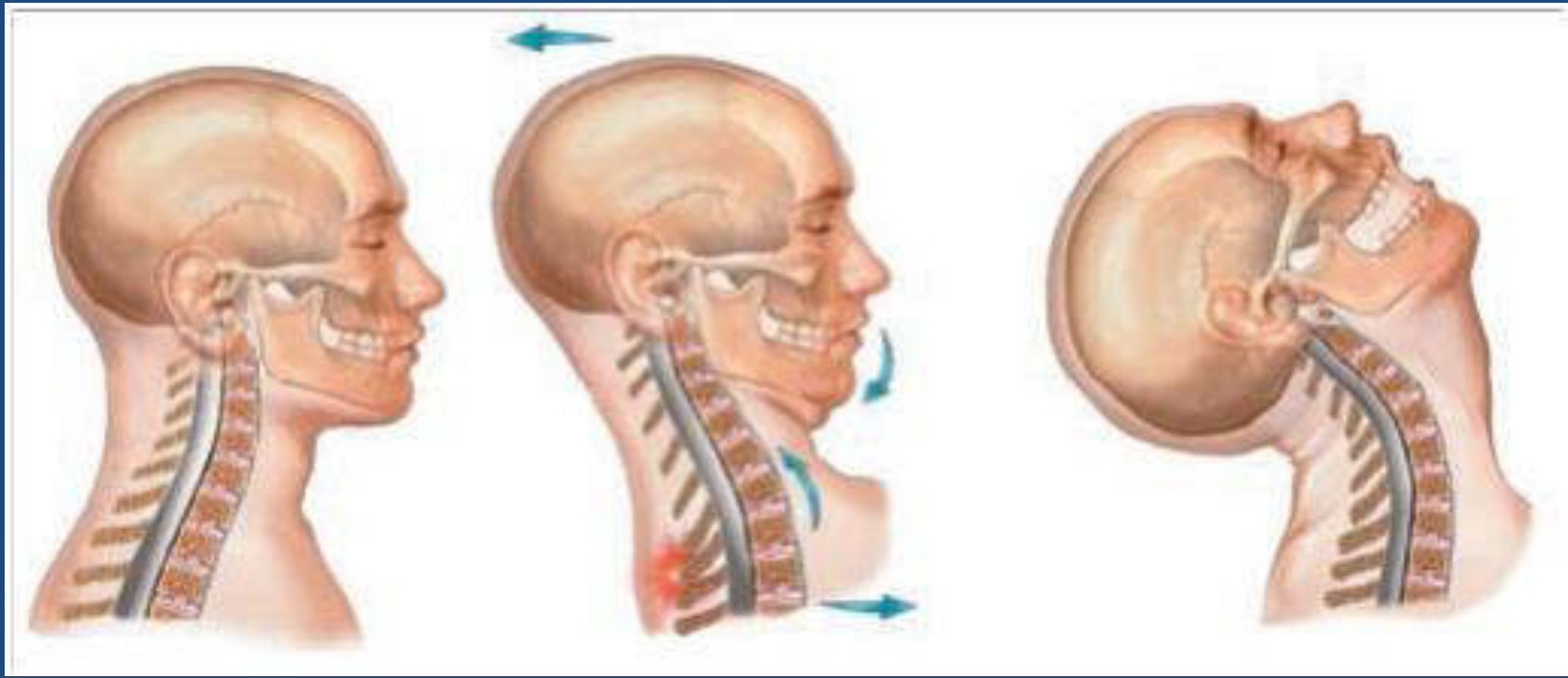
9.5% recumbent 23.7% upright

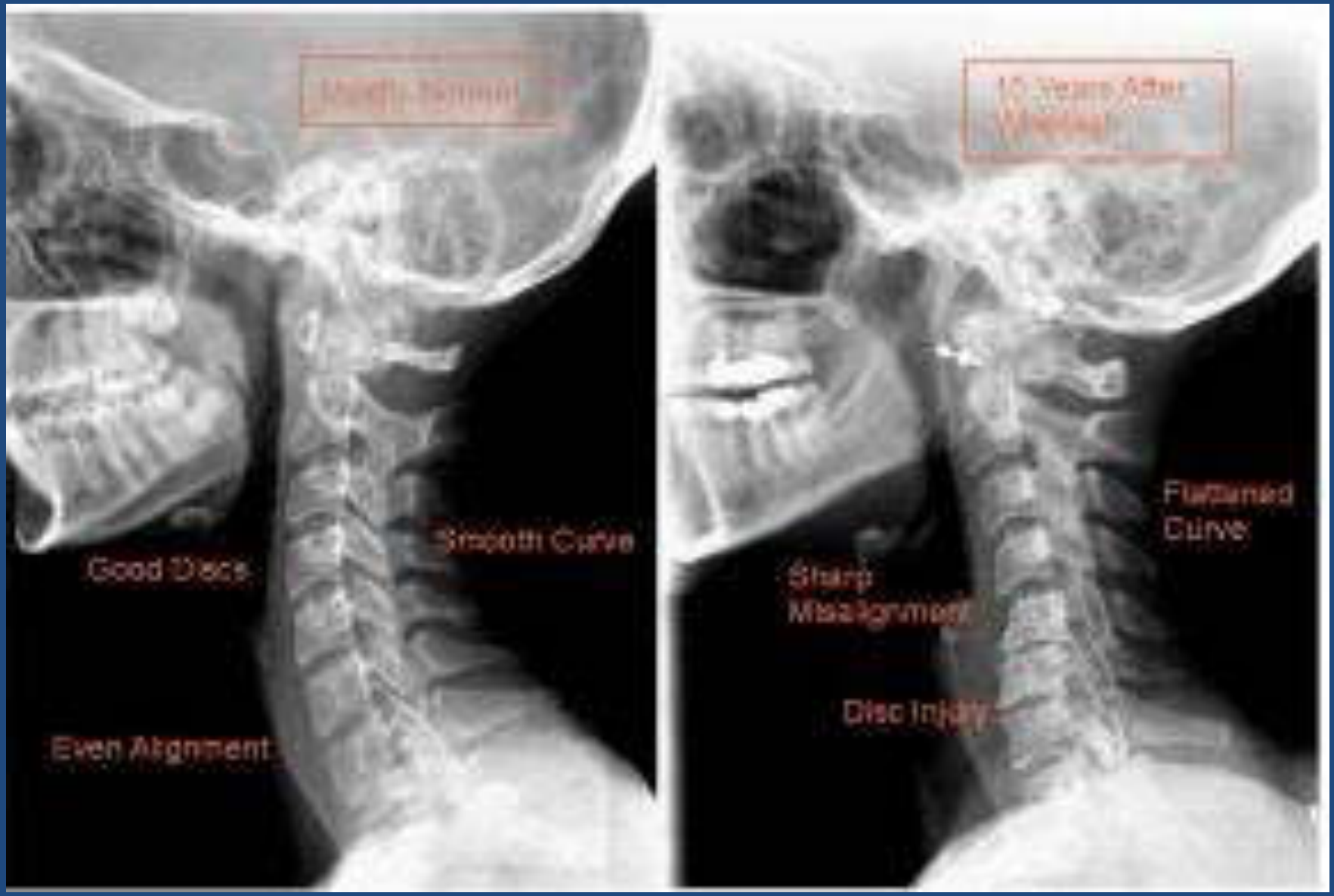
($\chi 2=0.0001$).

WHIPLASH ASSOCIATED DISORDER.

- Neck pain
- Headache
- Shoulder pain
- Difficulty Swallowing
- Blurred vision
- Ringing in the ears
- Nausea
- Fatigue & Weakness
- Irritability
- Dizzyness
- Vertigo

WHIPLASH ASSOCIATED DISORDER

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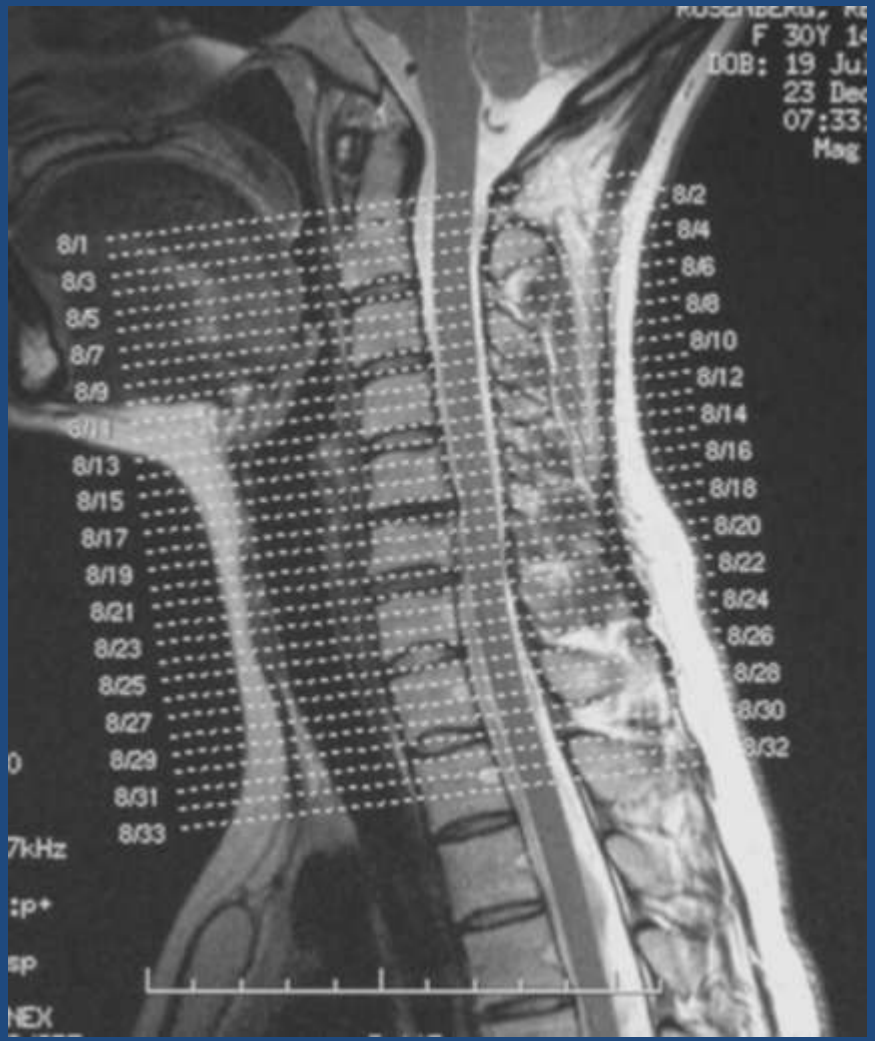
Smooth Curve
10 Years After
Sharp
Misalignment
Disc Injury
Flattened
Curve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Method and Materials :

40 patients 15 - 72 yrs. (Mean 48yrs),

All the patients previously investigated following hyperextension injury of the neck , who had reportedly normal MRI examination of the cervical spine were entered in to the study.

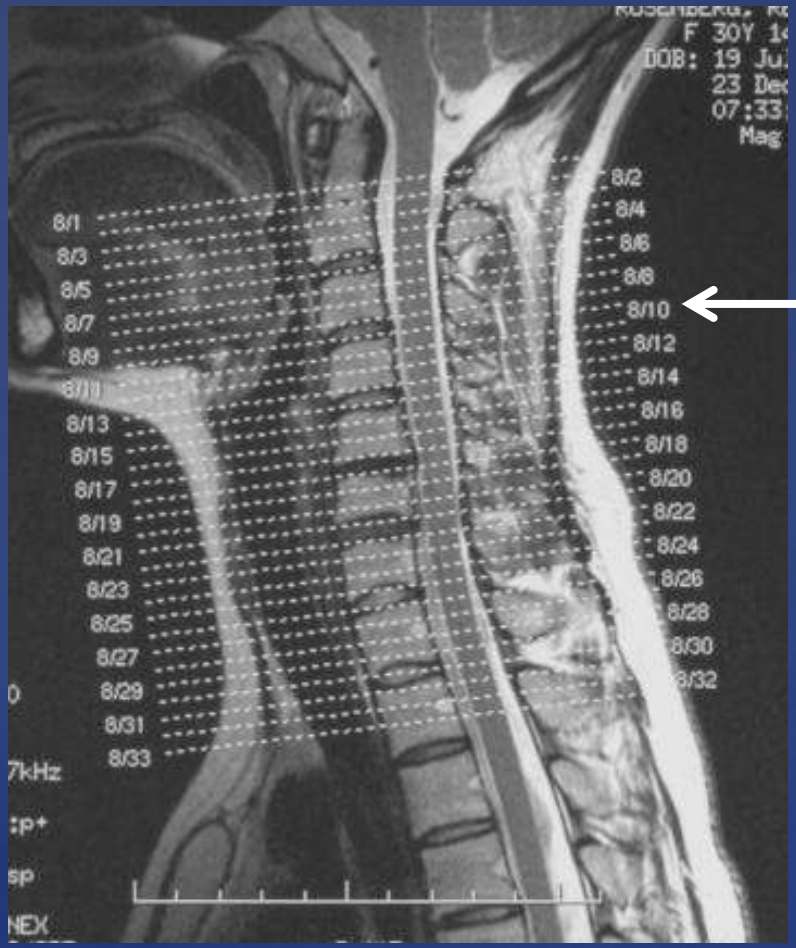
The previous MRI examinations had comprised :

Sagittal T1 & T2 weighted images

Axial T2 weighted images at all levels from C2 - T1

Conventional MRI examinations comprise:

Sagittal T1 & T2 weighted images
Axial T2 weighted images at all levels from C2 to T1



This Scout view from a conventional Supine (Lying down) MRI Scan, shows the limited levels at which the axial sections are made

You will note the junction between the head and spine is not routinely scanned (The cranio-cervical junction)

Patients are studied in the seated upright position

Images are made as follows:

All patients were scanned seated in an Upright MRI scanner

1. Sagittal T1 & T2 weighted images together with axial T2 weighted images at all levels from C2/3 to C7/T1
   (The same as is routinely performed in supine position)

2. Sagittal T2 weighted images with the neck in flexion and extension.

3. Coronal and axial proton density images made from the skull base down to the C2/3 level.

4. Axial proton density images of the atlanto-axial joints made with head turned to the right and to the left

All studies are assessed for:

- Spinal alignment and measurement of the Cervical Spine Angle
- Integrity of the intervertebral discs
- Integrity of the neck muscles
- Facet joint alignment
- Spinal instability
- Measurement of the Clivo-axial Angle, Grabb-Oakes interval and the Harris measurements.
- Alignment of the atlanto-axial joints and atlanto-occipital joints
- Integrity of the alar and cruciate ligaments
- Cerebellar tonsillar ectopia

RESULTS

In over 50% of patients (22), no additional information was gained.

In the other 18 patients, 16 showed ligamentous damage at the atlanto-axial joint, of which 10 had dislocation, 2 of which showed instability on the rotation images. 2 had atlanto-occipital joint dislocation.

Cerebellar tonsillar ectopia was seen in 10 patients.

CONCLUSION

When cost implications of under diagnosis of mechanical damage at the cranio-cervical junction is very large, the current practice of limiting imaging to below C2 is inadequate and under-estimates the incidence of post traumatic ligamentous damage.

For thorough MRI examination, imaging of the cranio-cervical junction is important, to find or exclude ligamentous damage.

CLINICAL RELEVANCE/APPLICATION

The cost implications of under diagnosis of mechanical damage at the cranio-cervical junction, both in terms of patient suffering and cost in insurance claims, is very large

We believe it is of paramount importance :

1. To show any dislocation and ligamentous damage when present
2. Also to exclude such damage when it is not present

(Unless it is specifically looked for, any damage at the cranio-cervical junction cannot be excluded from a limited cervical spine examination.)

The Craniocervical junction syndrome

Whiplash injury
Hypermobilty Spectrum Disorder
Ehlers Danlos Syndrome
Myalgic Encephalomyelitis (M.E.)
The chronic fatigue syndrome (C.F.S.)
Fibromyalgia rheumatica
Lyme disease
Chiari syndrome