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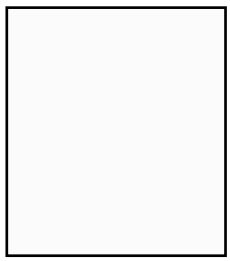

Cognitive Science

Research Papers

A Magnetic Resonance Image Description Language for Neuroradiology

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1. Introduction

The MEDIATE project is a collaborative venture the initial aim of which (the MR Tutor) is to provide a computer-based training system to help neuroradiology trainees develop the skills required to become experts in the field. In particular, the tutor is designed to:

1. Teach trainees a structured Magnetic Resonance (MR) Image Description Language (IDL).

2. Ensure that trainees are exposed to a wide range of cases representing the major brain diseases and gain an indication of the variation in visual features both between and within a disease category [Sharples00, Teather00, and duBoulay01].

3. Expose trainees to cases drawn from a variety of small worlds, where each small world consists of cases from diseases that produce similar images, and so help them to discriminate between potentially competing hypotheses [Hinkley01].

The basic domain representation underpinning the system is an archive of cases with confirmed diagnoses, all described by the same expert (G. du Boulay) using the IDL. These include separate descriptions for each image sequence/echo including detailed descriptions (e.g. the region, major position, exact location, margin, structure, shape, area, conformity to anatomical feature, interior pattern (if any), and intensities) of the lesion (or the largest of each type of lesion visible, where there are multiple lesions). Lesions that appear to consist of two or three distinct parts, either by their internal pattern or because different parts occupy different anatomical structures, may be specifically so described. The description also includes correspondence between described parts of lesions seen under different sequences and descriptions of atrophy, other signs (e.g. space occupation) and other abnormal signals for the case as a whole [duBoulay94].

This paper describes the full Image Description Language (as of 9/01/2002). Note that for the purposes of the prototype description training system (the MR Tutor) a simplified version of the description language has been used. It provides an initial set of terms to support discussion and sharing of knowledge amongst trainee neuroradiologists and their supervisors. It also serves as a structured representation of knowledge for the MR Tutor, enabling it to generate remedial responses to student errors.

2. Lesion Type

MRI is very sensitive in revealing abnormalities in brain tissues. The number of lesions revealed in a single brain may sometimes be very large. To provide detailed individual descriptions for every lesion may be a very lengthy task and unnecessary for diagnosis or management of treatment. Most of the lesions encountered can, however, be allocated by their IDL descriptions into one of 8-10 defined types. Recording the numbers, size range and dispersion of each type, together with a full description of the largest representative of each type probably provides almost as much information as would be available from all of the individual lesion descriptions.

Type is key to describing cases exhibiting multiple lesions. In the description process, the largest lesion of each type visible is described in detail. It is not necessary to indicate in detail, at the start of the description process, the particular type of lesion being described but simply to use the idea of type to group together lesions of similar appearance and/or structure as indicated below.

The decision as to whether or not some or all of the lesions are of the same type is made by examining the structure of the lesions on ALL available images.

In general terms, lesions fall into different types:

- Nodular or irregularly shaped, not more than 15mm in (true) diameter and without a focal structure.
- Diffuse, irregularly shaped, without a focal structure and more than 15mm in maximum diameter on at least one slice.
- Spherical with a homogeneous centre or highly suggestive of a cyst, with or without concentric rings of different intensities but not associated with a nodular mass or irregular surround.
- Containing a focal structure within a surround that is not exclusively concentric rings.
- Lesions with a focal structure may be further subdivided by their intensities
    - for lesions containing a focal structure to be of the same type, the pattern of the structure as it is described within this system should be the same and the intensity of the analogous parts of the lesion should

not differ in polarity on the same sequence (otherwise they are of different types).

- Lesions containing two or more distinct parts should be considered as being of the same type.

3. MR Image Description Language - Overview

3.1 Description without Contrast Medium

FOR EACH CASE

RECORD scanner id, patient id, scan date, user,
no of sequences, sequence/echo details,
discrete lesions,
no of types of lesion

FOR EACH TYPE (If Multiple Lesions)

RECORD no of lesions, size ratio, (dispersion)

SELECT LARGEST LESION
(If only one discrete lesion describe this lesion)

FOR EACH SEQUENCE/ECHO

RECORD lesion visibility, (position), (appearance)

FOR EACH LESION DESCRIBED

RECORD (correspondence)

FOR EACH CASE

RECORD (atrophy), (other signs), (other abnormal signals)

Note : () is used to indicate that a list of items is recorded

3.2 Post-Contrast Description

FOR EACH CASE FOR WHICH THERE IS A PRE-CONTRAST SCAN

RECORD scanner id, patient id, scan date, user,
no of post-contrast sequences,
post-contrast sequence details,
no of types of lesion on pre-contrast)

FOR EACH TYPE VISIBLE PRE-CONTRAST

CONSIDER LARGEST LESION DESCRIBED PRE-CONTRAST

FOR EACH POST-CONTRAST SEQUENCE/ECHO

RECORD lesion visibility post-contrast,
(position post-contrast),
(appearance post-contrast)

(additional lesions of
similar post-contrast appearance)

FOR EACH POST-CONTRAST SEQUENCE/ECHO

RECORD other additional lesions visible post-contrast,
(appearance post-contrast)

FOR EACH CASE

RECORD (post-contrast other signs)

4. MR Image Description Language – Full Specification

4.1 Description without Contrast Medium

FOR EACH CASE

Scanner ID

Alphanumeric

Patient ID

Alphanumeric

Scan date

Date

User ID

Alphanumeric

Number of sequences

Number

Sequence /Echo Details

List may be specific to imaging centre

Discrete Lesions

No discrete area of abnormal signals
Single discrete area of abnormal signals
Multiple discrete areas of abnormal signals

If Multiple
then specify Number of types of lesion

Number of Types of Lesion

Numeric

FOR EACH TYPE

Number of Lesions

Number

Size Ratio

> 8 : 1
Approx. 4 : 1
Approx. 2 : 1
Approx. 1 : 1

Dispersion (indicate all that apply for the particular type being described)

Cortical grey matter
Cerebral white matter
Juxta ventricular
Central grey nuclei
Intraventricular
Brain stem / Cerebellum
Pituitary fossa
Basal cisterns
Cortical subarachnoid space
Extracerebral
Skull or Neck
Orbits
Corpus callosum

SELECT LARGEST LESION

FOR EACH SEQUENCE/ECHO

Lesion Visibility (on sequence/echo)

Lesion visible
Lesion invisible
Lesion unavailable

If lesion visible
then describe position, appearance
else go to next sequence/echo

Position = region, major positions, exact locations

Region (select one only)

Left side
Right side
Bilateral
Bilateral & symmetric
Midline
Midline and left
Midline and right

Major Positions and Exact Locations (specify <u>all</u> that apply)

Major Position: Cortical grey matter
Exact locations:
: frontal
: parietal
: temporal
: occipital

Major Position: : Cerebral white matter
Exact Locations:
: central frontal
: central parietal
: central temporal
: central occipital
: peripheral frontal
: peripheral parietal
: peripheral temporal
: peripheral occipital
: internal capsule

Major Position: : Juxta ventricular
Exact Locations: : frontal
: body
: trigone
: temporal
: occipital

Major Position: : Central grey nuclei
Exact Locations: : caudate nucleus
: thalamus
: lentiform nucleus
: globus pallidus
: putamen

Major Position: : Intraventricular
Exact Locations: : lateral ventricles: frontal
: body
: trigone
: temporal
: occipital
: third ventricle
: fourth ventricle

Major Position: : Brain stem / Cerebellum
Exact Locations: : midbrain
: pons
: medulla
: cerebellar hemisphere : above fastigium
: at fastigium
: below fastigium
: cerebellar vermis : above fastigium
: at fastigium
: below fastigium

Major Position: : Pituitary fossa
Exact Locations: : intrasellar
: suprasellar
: parasellar

Major Position: : Basal cisterns
Exact Locations: : chiasmatic
: interpenduncular
: pontine
: medullary
: ambient
: quadrigeminal

: cerebellopontine angle
: cisterna magna
: crural

Major Position: : Cortical subarachnoid space
Exact Locations: : cerebral sulci space alone
: cerebral cortical subarachnoid space over gyri
: insula
: pericerebellar space

Major Position: : Extracerebral
Exact Locations: : frontal
: parietal
: temporal
: occipital
: scalp

Major Position: : Skull or Neck
Exact Locations: : skull vault : outer table
: : middle table
: : inner table
: : frontal
: : parietal
: : temporal
: : occipital
: skull base : foramina
: neck

Major Position: : Orbits
Exact Locations: : globe
: retro-orbital fat
: extrinsic eye muscle
: optic nerve

Major Position: : Corpus callosum
Exact Locations: : genu
: body
: splenium

Appearance = margin, internal pattern, lesion OR parts description

Margin

Mainly sharp
Graded

Outward facing profile naked (Yes/No)

Internal Pattern (overall)

Homogeneous
Lesion comprises single part with focal structure
Lesion composed of two distinct parts
Lesion composed of three distinct parts
Unstructured heterogeneous

If homogeneous,
single part with focal structure or
heterogeneous
then describe lesion

If two distinct parts
three distinct parts
then describe each part including internal pattern of part

Lesion Description = Shape, Area, No of slices, Abnormal blood vessels, Interior pattern of focal structure[**], Intensities

Part Description = Shape, Area, No of slices, Abnormal blood vessels, Part structure, Interior pattern of focal structure*[*], Intensities

[**] if appropriate

Shape (select single most appropriate)

Rounded
Oval
Linear
Irregular rounded
Irregular
Conforms to an anatomical feature

If Shape is Rounded
Oval
Linear
Irregular rounded
Irregular
then specify Area and No of Slices

If Shape is Conforms to an anatomical feature
then specify Anatomical Feature and Proportion Occupied
(Area and No of slices not appropriate)

Area

sq.cms

No of Slices

slice(s)

Conforms to Anatomical Feature : Feature List

Periventricular margin
Optic tract
Pyramidal tract
Quadrigeminal plate
Optic chiasm
Optic nerve
5th nerve
8th nerve
9th nerve
12th nerve
Extradural space
Subdural space
Basi-sphenoid
Basi-occiput
Petrous bone

Proportion Occupied

Whole
Approx. half
Less than a quarter

Abnormal blood vessels

No abnormal blood vessels present
Abnormal blood vessels present

Part Structure :

Homogeneous
Containing distinct focal structure
Unstructured heterogeneous

If Lesion or Part contains Focal Structure
then describe Focal Structure
and specify Intensitie(s) of both Focal Structure and Remainder

Interior Pattern of Focal Structure :

Homogeneous focal structure
Unstructured heterogeneous focal structure
Multiple repetitive focal structure
Concentric layers: single focal structure
Concentric layers: single elements of mult.repetitive focal structure
Concentric layers: mult.repetitive centre

Intensity

Reference :

cerebral white matter
cerebellar white matter

If homogeneous lesion/part/focal structure
then specify single intensity

If heterogeneous lesion/part/focal structure
then specify all relevant intensities

Intensities

Specify on the scale :

+++
++
+
Isointense
-
--

FOR EACH TYPE

Correspondence

(Recorded when part of a lesion is also seen image obtained from a different sequence/echo or orientation)

No correspondence
Correspondence in appearance
Correspondence not relevant

If Correspondence in appearance
then specify sequences and relevant correspondence

Sequences

User input

Correspondence in Appearance :

Lesion with Lesion
Lesion with Part
Lesion with Focal Structure
Part with Lesion
Part with Part
Part with Focal Structure
Focal Structure with Lesion
Focal Structure with Part
Focal Structure with Focal Structure

FOR EACH CASE

Atrophy

Expansion of the cortical sulci :

Zero quadrants
One quadrant
Two quadrants
Three quadrants
Four quadrants
Unrecordable

Dilatation of the lateral ventricles :

None
Moderate
Marked
Unrecordable

Dilatation of pontine and CP cisterns :

None
Moderate
Marked
Unrecordable

Expansion of Sylvian fissure :

None
Moderate
Marked
Unrecordable

Overall Atrophy Score : Calculated from above

Other Signs (each Present, Absent or Unrecordable)

Mass effect
Expansion of fourth ventricle
Expansion of basal cisterns
Dilatation of third and both lateral ventricles
Localised loss of brain substance
Dilatation of Virchoff-Robin spaces

Other Abnormal Signals (not already described as a lesion)

Diffuse areas
Discrete areas
No further abnormal signals

If Diffuse areas or
Discrete areas
then specify Location of areas

Location of Areas of Abnormal Signal (specify all)

Cortical grey matter
: frontal
: parietal
: temporal
: occipital

Cerebral white matter
: central frontal
: central parietal
: central temporal
: central occipital
: peripheral frontal
: peripheral parietal
: peripheral temporal
: peripheral occipital
: internal capsule

Brain stem / Cerebellum
: midbrain
: pons
: medulla
: cerebellar hemisphere. : above fastigium
: at fastigium
: below fastigium
: cerebellar vermis : above fastigium
: at fastigium
: below fastigium

4.2 Post Contrast Image Description

FOR EACH CASE

Scanner ID

Alphanumeric

Patient ID

Alphanumeric

Post-Contrast Scan date

Date

User ID

Alphanumeric

Number of post-contrast sequences

Number

Post-contrast Sequence /Echo Details

List may be specific to imaging centre

FOR EACH TYPE VISIBLE PRE-CONTRAST

CONSIDER LARGEST LESION VISIBLE PRE-CONTRAST

FOR EACH POST-CONTRAST SEQUENCE/ECHO

Lesion Visibility Post-Contrast

Lesion visible
Lesion not visible

Position Post-Contrast

As described Pre-Contrast ? (Yes, No)

If No
then specify Position using Major Positions and Exact Locations

Appearance Post-Contrast

If pre-contrast structure NOT comprising parts
then describe effect of enhancement on lesion

If pre-contrast structure comprises two or more distinct parts
then describe effect of enhancement on each part

Effect of Enhancement on Appearance of Lesion/Part

Throughout lesion/part
Focal structure only
Focal structure appeared
All except focal structure
Ring enhancement
Extends beyond lesion/part edge
Of pathological blood vessels
Did not enhance
Other than patterns described above

Enhancement reflects pre-gadolinium morphology ? (Yes/No)

CONSIDER OTHER LESIONS OF SAME TYPE PRE-CONTRAST

Other Lesions of same type - Enhancement

All enhanced
Some enhanced
None enhanced

If All or Some Enhanced
then specify Effect of Enhancement on Appearance

Effect of Enhancement on Appearance of (Majority of) Lesions of Same Type

Throughout lesion
Focal structure only
Focal structure appeared
All except focal structure
Ring enhancement
Extends beyond lesion edge
Of pathological blood vessels
Other than patterns described above

Additional lesions of similar post-contrast appearance

Additional lesions appeared of similar post-contrast appearance ? (Yes/No)

FOR EACH POST-CONTRAST SEQUENCE/ECHO

Other additional lesions visible post-contrast

Other lesions appeared not resembling
post-contrast appearance of any type above ? (Yes/No)

If Yes
then specify Appearance Post-Contrast

Appearance Post-Contrast

Throughout lesion
Focal structure only
Focal structure appeared
All except focal structure
Ring enhancement
Extends beyond lesion edge
Of pathological blood vessels
Other than patterns described above

Post-contrast other signs

Meningeal enhancement

Widespread enhancement

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