

ADVANCES IN NEUROIMAGING

LYNETTE MASTERS

I-Med Radiology

BMC

CAT (CT) SCAN



COMPUTERISED AXIAL TOMOGRAPHY

- The first CT scanner was built by Godfrey Hounsfield in 1971, who worked for EMI
- It combines Xrays and tomography with computer post processing to produce images
- 1979 Nobel prize in Medicine



MAGNETIC RESONANCE IMAGING

- A strong magnetic field changes the orientation of the hydrogen atoms in the body
- As they return to their steady state they emit small radio waves.
- These are detected, and the intensity of the received signal is plotted on a grey scale to create an image
- Paul Lauterbur (NMR) and Peter Mansfield (mathematics) shared the Nobel prize in Medicine in 2003

MRI

- 1.5T vs 3T vs 7T vs 9.4T vs 10.5T
- 10.5T scanner at the University of Minnesota weighs more than 3 times a Boeing 737 plane *Nature* 563, 24-26 (2018)
- Clinical scanners are 1.5 or 3T
- Tesla: strength of the magnetic field (unit of magnetic flux density)



CONTRAINDICATIONS FOR MRI

- Pacemaker (MRI compatible pacemakers)
- Metallic ocular foreign body
- Cochlear implants, and some stapes implants
- Some cerebral aneurysm clips

WHAT'S NOT CONTRA-INDICATED FOR MRI

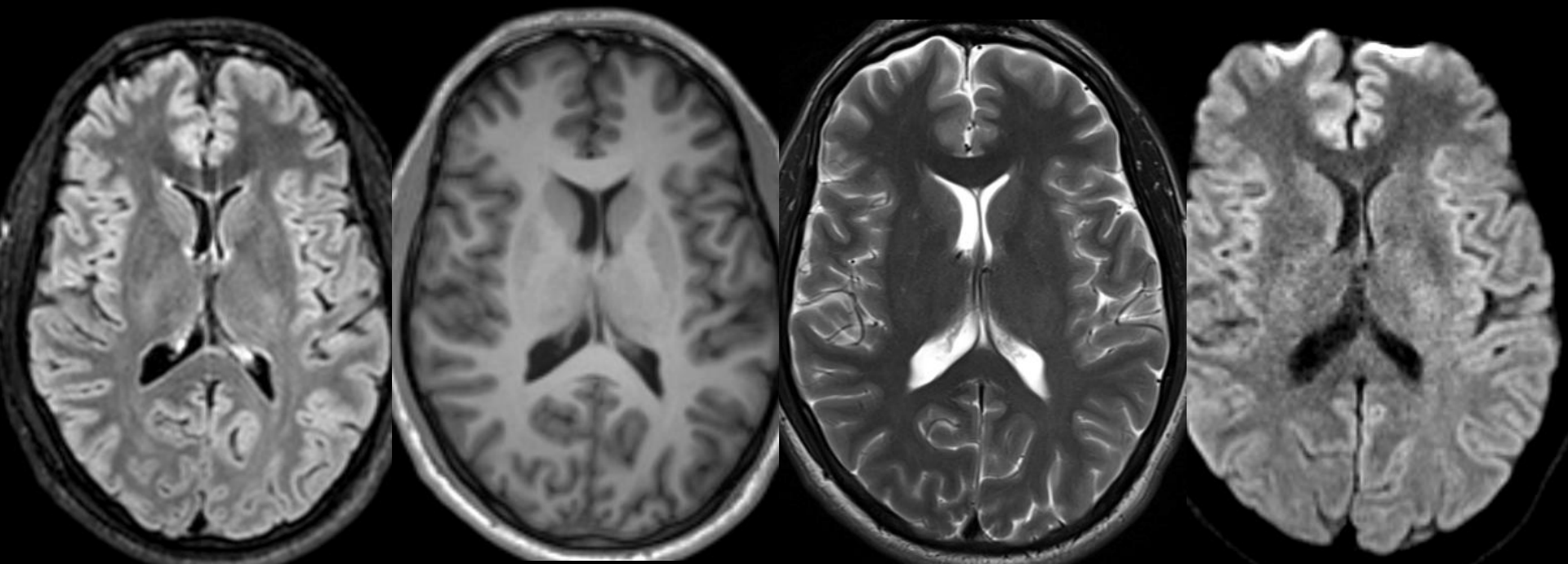
- Joint prostheses
- Metallic spinal fusion hardware
- Cardiac valves

WHY DOES MRI RULE?

- No ionising radiation
- Multiplanar imaging and superior tissue contrast increase diagnostic accuracy by improving lesion detection, better defining it anatomically, and often providing insights to the diagnosis

MRI STRUCTURAL SCANNING

- Normally takes about 20 minutes
- Different sequences which provide complementary information about the location and possible cause of any abnormality
- Contrast administration



MRI CONTRAST

- Intravenous gadolinium
- May help with the type of tumour
- Helps to differentiate between tumour and adjacent brain reaction.
- Helpful post-operatively

“ADVANCED TECHNIQUES”

- MRS
- DTI
- Perfusion scanning
- Functional MRI

MR SPECTROSCOPY

- Can be used to help characterize abnormalities
- May help to distinguish between recurrent tumour and radiation necrosis

DIFFUSION TENSOR IMAGING

- Provides information about the structure and connections of white matter in the brain.
- Can be of assistance in planning the best surgical approach

PERFUSION IMAGING

- A contrast enhanced technique
- Can be used to help identify the potentially most high grade component of a tumour for biopsy

FUNCTIONAL MRI

- Helpful in identifying “eloquent” brain.
- Typically speech and motor function
- Task based or resting state

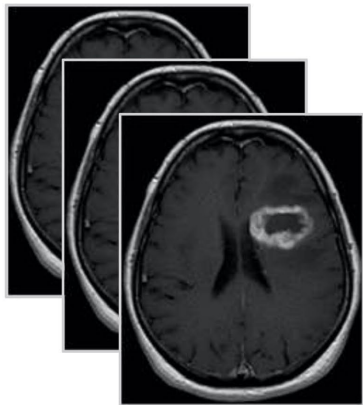
RADIOMICS

- Radiomics is a field of biomedical imaging using advanced non-invasive assessments of complex imaging characteristics within the MRI images that are too complex for a human to appreciate

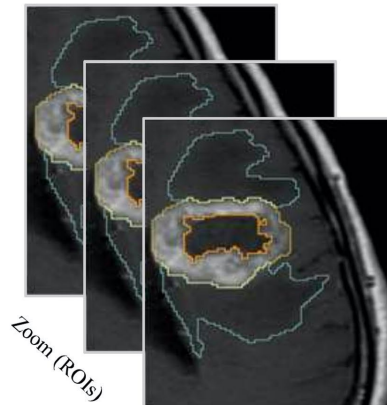
RADIOMICS

- Radiomics incorporates several important disciplines, including radiology (eg, imaging interpretation), computer vision (eg, quantitative feature extraction), and machine learning (eg, classifier evaluation). A central goal is the identification of quantitative imaging indicators that predict important clinical outcomes, including prognosis and response or resistance to a specific cancer treatment

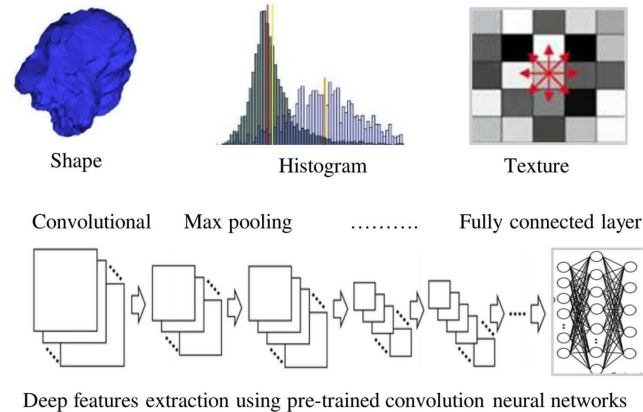
1. MR images



2. Tumor labelling



3. Features extraction



4. Statistical analysis

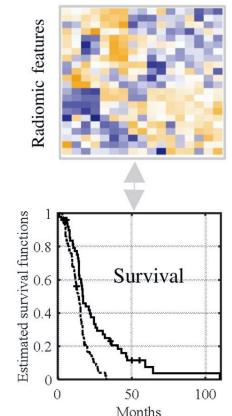
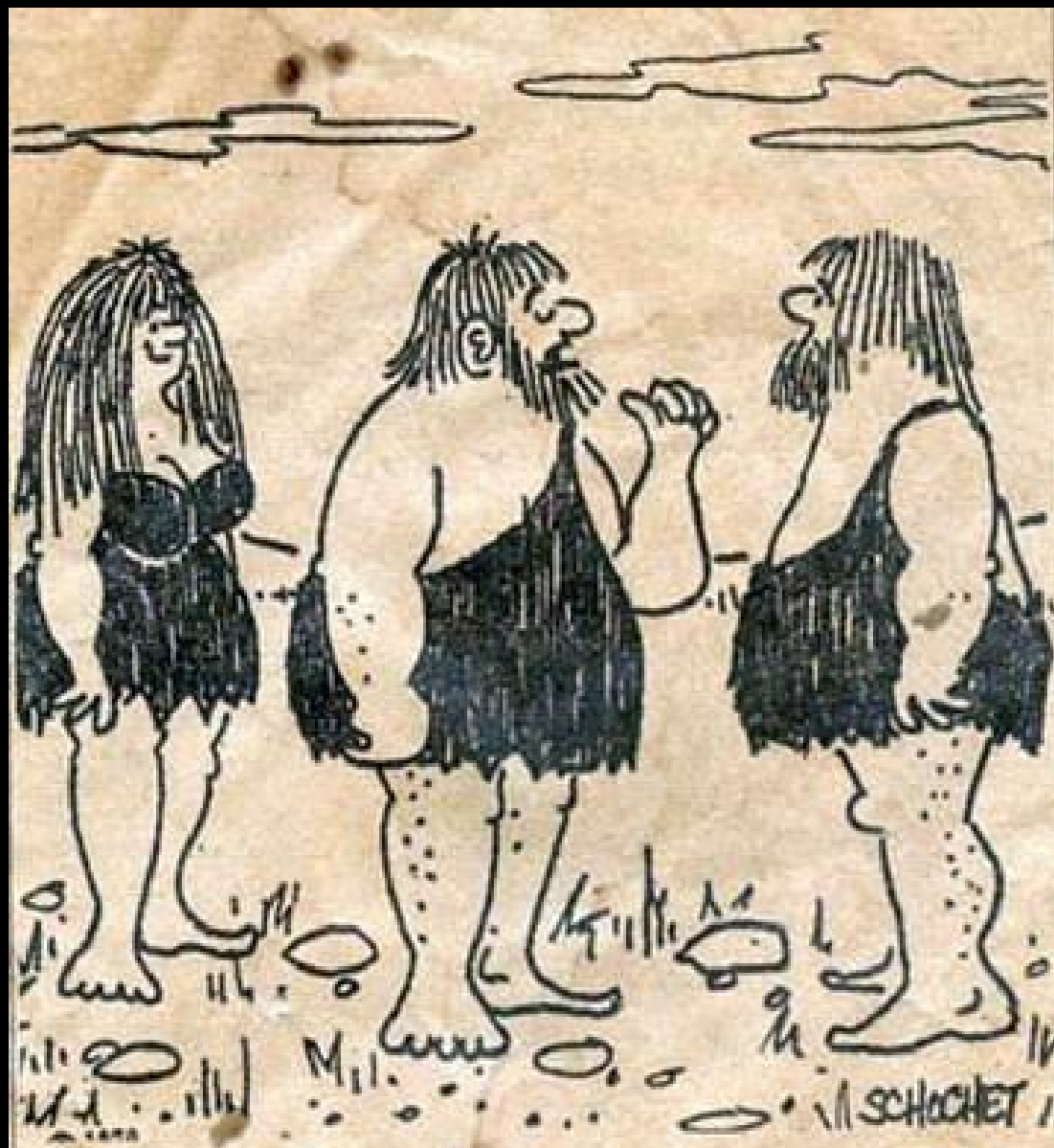


FIGURE 1 | Standard pipeline of the radiomics analysis. (1) MR Image acquisition with a standardization. (2) Tumor labeling viewing in 3D (e.g., red, yellow and cyan contours). (3) Radiomic features extraction using shape, texture and convolution neural network techniques. (4) Statistical analyses, based significance test and classifier models, to identify relevant features for predicting the clinical outcome.

PET SCANNING

- A nuclear medicine technique that involves injection of a radio-isotope and subsequent scanning
- May be useful in distinguishing between tumour recurrence and treatment effect



"I've decided to teach her to talk, what harm can it do?"