This is Our Brain

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For Inga and Olivier

Preface

This book was written for everyone who would like to know how our brain really looks like, in real MRI and CT scans rather than schematic representations of our brain. The brain is the part of our body which is most often subjected to medical imaging. Many people now have experience of lying in an MRI or CT scanner. Nearly everyone knows someone—be it a friend or a relative—who has undergone an MRI or CT procedure. In addition to the brain, this book will also discuss the body parts adjacent to the brain, such as the skull, the paranasal sinuses and the vertebral column. This book will both describe and visualise the main abnormalities which can be identified in MRI or CT images. Generally, these will be ageing-related abnormalities and common syndromes such as cerebral infarctions, skull fractures and spinal hernias. In addition to clear descriptions, each subject will be illustrated with an MRI or CT image. Each MRI or CT image will come with a clear description next to it.

Although many things can go wrong with our brain, this book will also show you how strong our brain is. Our brain is capable of overcoming adversity, and often emerge all the stronger because of it.

Utrecht, The Netherlands — Jeroen Hendrikse

The original version of this book was revised. An erratum to this chapter can be found at DOI 10.1007/978-981-10-4148-8_41

Contents

Chapter 1
CT and MRI Scans: The Basic Principles

CT and MRI scanners enable doctors to reduce the human body to slices just a few millimetres thick. Until the arrival of CT and MRI scanners in around 1980, it was not possible to do so. At the time, X-ray images were unable to show us individual slices of the body. To understand why this was important, imagine an unsliced loaf of bread. Unsliced bread does not reveal its inner secrets, much like the skull does not reveal the secrets of the brain. Until 1980, doctors had to guess as to what went on inside a patient's skull. Generally, they were unable to take a detailed look at a patient's brain until the patient had died and they had opened his or her skull. They would then literally slice the dead patient's brain to determine the cause of his or her disease. CT and MRI scanners allow doctors to 'slice' a living patient's brain without opening his or her skull. In this way, CT and MRI scanners have allowed doctors to visualise the cause of a patient's brain abnormalities since 1980. CT scans visualise the details of the body by means of X-ray images of thin slices of the body. MRI scanners use a strong magnet to achieve the same effect. CT scans hold the advantage of requiring less time inside the machine. It only takes several seconds or minutes to perform a CT scan, whereas MRI scans often take 20 min to complete. Another advantage of CT scans is that they allow for the easy identification of bones and bone fractures.

An example of a CT scanner, as well as an example of an MRI scanner, can be found on the next page.

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One of the disadvantages of CT is the use of X-ray technology, which poses certain small risks. In practice, the advantages of CT scans far outweigh the very slight disadvantages. However, if an MRI scan can be performed instead of a CT scan, doctors will often opt for performing the MRI scan. The disadvantage of MRI is that the tunnel is slightly longer, which may cause claustrophobic patients to suffer anxiety attacks. MRI is useful for brain scans since it renders more details visible, thus enabling doctors to identify small abnormalities in the brain.

The top image on the next page shows a CT scanner. A CT scanner is basically a giant doughnut turned on its side, with a large hole in the middle. The patient will lie on a table which will move during the examination (circle). During the examination, this moving table will slide a small part of the patient into the cavity at the centre of the scanner (arrow). While the patient moves through the centre of the machine, a CT scan of, say, the brain will be performed.

The bottom image on the next page shows an MRI scanner. In a way, MRI scanners look much like CT scanners, except the hollow part inside the doughnut is longer. They are basically several doughnuts stacked together, then turned on their sides. Before the start of an MRI scan, the patient will be placed on the table (circle), which can move into and out of the MRI scanner. Before the start of the MRI scan, the part of the body which must be visualised will be moved to the centre of the MRI scanner (arrow). During the scan, the patient will stay in the same place. MRI scanners tend to be very noisy while performing scans, so patients are provided with ear plugs to minimise the inconvenience.

Chapter 2
CT and MRI Scans: Different Types of Images

Both CT scanners and MRI scanners can 'slice' the body in various directions. Horizontal scans are the most commonly used. Horizontal scans can be compared with slicing off the top of a boiled egg. To get an idea of what a horizontal CT or MRI slice is like, trace your index finger from one ear to the other, passing your cheeks and the tip of your nose along the way. This equals a horizontal MRI slice of your head and brain. When an MRI or CT scan of the head is performed, the entire head and brain are sliced in this direction.

However, the body can be sliced in two other directions, as well. The first direction involves dividing the body into left and right halves. The middle slice scanned in this direction will be a slice directly dissecting the patient's nose (see image on the next page). To get an idea of what this type of scan is like, place your index finger on your forehead and now trace it down across the bridge of your nose, mouth and chin. This is the second direction in which the MRI and CT scanners produce slices of the head and brain. The third direction involves dividing the body into front (anterior) and back (posterior) halves. To get an idea of what this involves, trace your index finger from one ear to the other across the crown of your head. CT and MRI scans often involve slicing the brain from various directions.

Not only are scans performed from various directions, but also there are several types of scans, as well. Patients will mainly notice that with both CT and MRI scans of the brain, images are produced both before and after the patient is injected with a type of fluid. In certain patients, this injected fluid can provide additional information. Generally, the fluid is intravenously administered through the elbow fold, after which it spreads over the body's blood vessels. This helps doctors visualise abnormalities in the vessels in question. In addition, the injected fluid can help doctors determine whether any vessels are leaking.

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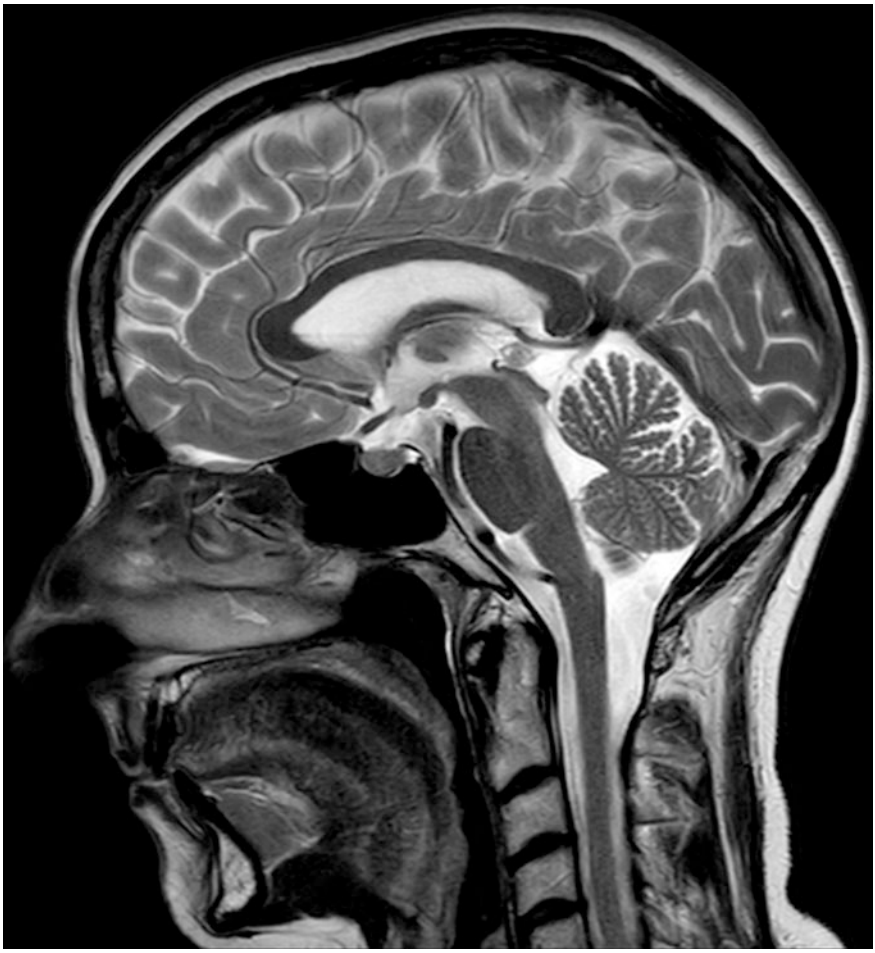

Normally, cerebral blood vessels are well insulated, so they do not leak. Some diseases of the brain may cause the vessels to springs leaks. If this is the case, the injected fluid leaks will be able to be seen in a CT or MRI scan of the brain. Scans made before and after the injection of the fluid will be compared to identify small leaks.

MRI scans often involve the performance of quite a few scans. An MRI scan can be compared to a music album featuring a series of songs. Each type of MRI scan takes 1–5 min to complete, and all songs taken together, a regular MRI scan will take about 15–30 min to complete. The various individual MRI scans will each provide unique information about the brain.

The image on the previous page shows an MRI image produced using a technique which is sensitive to water. Such MRI images are also known as 'scans'. When the brain is irritated, the amount of water may increase in places where one would not normally expect there to be much water. This type of MRI scan is good at visualising this. Pictured on the next page is an MRI scan produced using a technology which is sensitive to blood vessels. Over the years, dozens of clever types of MRI scans have been developed. An MRI scan of the brain often involves between 4 and 7 different types of MRI scan. What types of MRI scan a patient will be subjected to is determined on the basis of the patient's symptoms.

With CT scans, it is easier to try and remember what white, grey and black stand for. The various shades of grey are determined by the amount of X-ray radiation the various body parts block. Bones block a great deal of radiation. As a result, they show up white on CT scans. Air does not block any radiation; therefore, it shows up black on CT scans. Muscles and brain appear light grey, while fat appears a very dark grey. Water is a shade of grey somewhere between the shades of grey associated with muscles and fat. Although the order of greyness is fixed, it is sometimes vital that shades of white be rendered less white, and shades of black less black—for instance, to render small skull fractures more visible. In order to better visualise such fractures, the bone of the skull will be rendered less white.