Scans and tests after brain injury

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Introduction

There are a range of different types of brain scans and tests that are commonly used to diagnose and monitor brain injury. The type of scan used will depend on the nature of the injury, as different scans are sensitive to different things. Medical teams responsible for carrying out scans will decide which type is most suitable depending on things such as type of injury, location of the injury and the effects that are being experienced.

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This publication provides information about various scans that are commonly used and what to expect if a survivor is referred to any of them. It is written for brain injury survivors, as well as families and carers.

The words highlighted in **bold** are defined in a glossary at the end of the publication.

Who is responsible for carrying out scans/ tests?

All scans and tests consist of two stages: the scan/ test being carried out, followed by interpretation of the scan/ test results.

A **radiographer** is responsible for operating scanner equipment and conducting the scan itself.

A **radiologist** is responsible for interpreting the results of the scan and sending a written report to your doctor or consultant. You will then be given information about what your scan has shown and what the results mean.

X-ray

What is an X-ray and when is it used?

X-rays are a form of radiation that can harmlessly pass through the body. An X-ray machine is used to direct X-rays at an affected part of the body, which a detector on the other side then creates images of. X-rays pass through the body at different rates depending on the density of the tissue. For example, as bones are very dense, X-rays cannot pass through them, and they therefore show up clearly in white on X-ray images. Organs are soft so X-rays can pass through, and these show up in darker shades.

An X-ray may be used to identify any damage caused to bones, such as fractures in the skull. However, X-rays of the head are gradually being replaced by CT scans. For more information on this, see the section *Computerised Tomography (CT)*.

What happens before an X-ray?

There are usually no special preparations required for having an X-ray.

What happens during an X-ray?

The radiographer will ask you to lie down or sit down depending on which part of the body needs to be X-rayed. The machine will be positioned and the radiographer will go behind a screen to take the X-ray.

It is important to stay still while the X-ray is being taken so that the images are as clear as possible. You will not see or feel anything while the X-ray is being taken. More than one X-ray might need to be taken from different angles.

In total, the whole process takes a few minutes.

What happens after an X-ray?

Once the X-ray is complete, you will be able to go home. There are no after-effects of having an X-ray.

What are the possible risks of X-rays?

X-rays use a very small amount of radiation. However, each X-ray is calculated to take the best image with the minimum amount of radiation. The risk of developing any problems in the future are minimal.

Computerised Tomography (CT)

What is a CT scan and when is it used?

A CT scan, also sometimes called computerised axial tomography (CAT), uses a series of X-rays to take detailed pictures of internal areas of the body. It is usually the first type of scan to be used after a brain injury is suspected.

A CT scanner looks like a big ring with a scanner bed attached. Inside the ring, X-rays rotate around a body inside the scanner, which are picked up by detectors on the other side. Through this process, multiple images of the skull and brain

are taken from different angles to create a detailed 3D internal image of the head. This can then be used to identify the location and extent of brain injury.

CT scans are quick to administer and less sensitive to movement compared to other types of scans, making them a useful tool in a medical emergency. They are also commonly used for follow-ups to monitor injury and provide information for treatments or tests.

What happens before a CT scan?

No special preparations are usually required for having a CT scan. However, sometimes a small injection containing a **contrast dye** is given before the scan. The **contrast dye** makes CT images clearer and helps in detecting abnormalities. If a **contrast dye** is required, you will be given more information and an opportunity to ask any questions you might have beforehand.

What happens during a CT scan?

The radiographer will ask you to lie on the scanner bed, which will slowly move into the CT scanner. The scanner does not surround the entire body at once, so will hopefully not cause you too much discomfort.

The radiographer will then leave the room to operate the scanner from an adjoining room. You will still be able to hear and speak to the radiographer through an intercom while the scan is taking place.

CT scans generally last around 15 minutes.

What happens after a CT scan?

When the scan is finished, the radiographer will return to the room and help you out of the scanner. You can leave straight away as there are generally no after-effects of having a CT scan.

If the scan involved a **contrast dye**, you might have to wait for an additional 15 to 30 minutes after the scan to make sure there are no adverse effects.

What are the possible risks of CT scans?

CT scans use a series of X-rays, so involves exposure to a very small amount of radiation. However, every effort is made to keep the radiation low.

The **contrast dye** required for some CT scans contains iodine. You should therefore inform the radiographer before the scan if you are allergic to iodine. More information about contrast dyes will be provided to you by your doctor or the radiographer.

If you have any concerns about the risks and require more information, your doctor and radiographer will be able to answer any questions you may have.

Magnetic resonance imaging (MRI)

What is an MRI scan and when is it used?

MRI scans use magnetic fields and radio waves to take very detailed pictures of internal parts of the body from different angles. The MRI scanner looks like a CT scanner, and has an open ring-like structure with an attached scanner bed. However, MRI scanners are longer, a bit like a tube, and the scanner surrounds more of the body compared to CT scanners.

You might be referred for an MRI scan to obtain detailed information about your brain injury. It can be used to plan treatments and check how effective they are.

What happens before an MRI scan?

Before you have your MRI scan, you will be asked to fill in a safety checklist that will ask about your health and whether you have any metal implants. This is because MRI uses powerful magnets, so any metal embedded in your body (such as pins, aneurysm clips or coiling) can distort images and be moved slightly by the scanner. It is therefore of utmost importance to be honest in the safety checklist if you have any metal in your body or if you are carrying any metal (such as watches, phones, coins or jewellery).

If families and carers would like to stay in the scanner room with you, they will also be asked to complete a safety checklist to make sure they have no metal

on them.

You might also be asked if you have claustrophobia (a fear of enclosed spaces), as the scanner can be a tight, enclosed space in which you will be required to lie still for some time. If you are claustrophobic, hospital staff might be able to provide you with some coping mechanisms beforehand and will reassure you at all times during the scan (you will be able to talk to them while in the scanner).

You will also be asked whether you have tinnitus (ringing in the ears), as noise from the scanner might affect this.

There are no further special preparations required for having an MRI scan. In some cases, an injection with a **contrast dye** might be given to make images clearer. If you require an injection, the radiographer or your doctor will explain this to you in more detail.

What happens during an MRI scan?

Following the initial screening, the radiographer will ask you to lie on the scanner bed and will provide you with some ear protection as the scanner can be quite loud. You may also have your head placed in a frame (like a helmet), as this can help with taking clearer images.

Once you are comfortable and inside the scanner, the radiographer will leave the room to operate the scanner from an adjoining room. There will be an emergency buzzer if you feel like you need to be removed from the scanner at any time. There will also be an intercom system through which you can hear and speak to the radiographer.

MRI scans usually last between 20 minutes to an hour.

What happens after an MRI scan?

When enough images are taken, the radiographer will come back into the room to remove you from the scanner. There are no after-effects of MRI so you should be able to leave soon after having the scan.

If the scan involved a **contrast dye**, you might have to wait for an additional 15 to 30 minutes after the scan to make sure there are no adverse effects.

What are the possible risks of MRI scans?

MRI scans carry no risks and so far there have been no reported ill-effects of being exposed to high magnetic fields. However, some people may experience dizziness and/ or headaches after lying down in the scanner for a length of time.

MRI is not suitable for people who have metal inside their body, such as pacemakers or surgical clips. It can also be a difficult experience to be in an MRI scanner if you have claustrophobia.

The **contrast dye** required for some MRI scans contains iodine. You should therefore let the radiographer know if you are allergic to iodine.

If you have any questions about the risks of procedures of an MRI scan, your doctor or radiographer will be there to answer any concerns that you have.

Positron emission tomography (PET)

What is a PET scan and when is it used?

PET scans involve the administration of a **radiotracer** which emits low levels of radiation that the scanner detects to produce detailed 3D images of activity in the brain. The scanning machine looks similar to an MRI scanner. PET scanning is a safe procedure. It is frequently used in combination with CT or MRI scanners (known as a **combination scan**) to take clearer pictures of brain tissue following an injury.

PET scans are used to detect activity in the brain and so can be helpful with diagnosing epilepsy, severe brain injury or disorders of consciousness.

What happens before having a PET scan?

Having a PET scan usually requires some preparation in advance. You might be required to stop eating and abstain from doing any strenuous exercise for 6

hours beforehand. Your appointment letter will outline details of any preparation that you need to do before going for your PET scan.

About one hour before your scan, you will be given an injection that contains a **radiotracer**. This is what the PET scanner will be detecting while you are having the scan.

What happens during a PET scan?

Following the injection, you will be asked to lie on the PET scanner bed. Once you are comfortable, the radiographer will move the bed inside the scanner.

There will be an emergency buzzer if you feel like you need to be removed from the scanner at any time. There will also be an intercom system through which you can hear and speak to the radiographer.

PET scans usually last between 30 minutes to an hour.

What happens after a PET scan?

When enough images are taken, the radiographer will come back into the room to help you out of the scanner. There are generally no after-effects of PET so you should be able to leave soon after having the scan.

You might be advised to drink plenty of fluids to flush the radiotracer out quickly.

What are the possible risks of PET scans?

PET scans involve the use of **radiotracers**, which contain a mildly radioactive substance. However, the amount of radiation you will be exposed to will be very small, and therefore has minimal risks. The **radiotracers** leave the body completely within 3 - 4 hours. The radiographer, radiologist and your doctor will always make sure the benefits of having a PET scan outweigh the risks.

If you are referred to a **combination scan**, the risks will be the same as having a CT or MRI scan, as well as the PET scan risks listed above.

More information and details of the procedure for combination scans will be provided to you by your doctor or radiographer.

Other scans and tests

The scans mentioned in the previous sections are commonly used to detect and monitor brain injury. However, there are a range of other scans and tests that are used in the investigation of specific conditions or effects of brain injury. These are covered in some detail below.

Electroencephalography (EEG)

An EEG detects areas of brain activity by measuring natural electrical activity in the brain (brain cells communicate with one another and process information through electrical signals). This activity is measured using **electrodes** that are placed on the surface of the scalp, which is a painless procedure.

An EEG is a useful test that can detect and monitor abnormal brain activity after a brain injury. It is also used to provide helpful information on certain effects of brain injury, such as problems with memory and sleeping. EEGs are also very commonly used to investigate cases of epilepsy.

Prior to having an EEG, you might be advised to wash your hair, as this will help the **electrodes** stick to your scalp. A gel will often be applied to the scalp to help the **electrodes** detect brain signals more easily. In some cases, an elastic cap (similar to a swimming cap) with the **electrodes** already attached to it is used instead. These **electrodes** are linked to a computer, so that brain waves can be recorded.

Whilst the EEG is taking place, you will be asked to complete certain tasks, such as looking at pictures or breathing deeply for a few minutes.

An EEG usually lasts about 30 minutes to an hour due to the preparation required before the actual test.

After the EEG, the electrodes will be removed and your scalp will be cleaned of

any remaining gel. There are no after-effects of having an EEG and you will be able to go home shortly after.

EEG tests are a painless and safe procedure. You will feel little or no discomfort from having an EEG, as the **electrodes** don't emit any electricity and do not hurt. There is a small risk that certain tasks you may be required to do during an EEG can induce a seizure if you have epilepsy, for instance if there are flashing lights. However, there will be medical staff with you at all times should you need any support or assistance.

Single-photon emission computed tomography (SPECT)

SPECT scans are similar to PET scans as they rely on an injected **radiotracer** to take images of internal parts of the body. However, the **radiotracer** used in SPECT stays inside the body for longer than in PET and can detect areas of reduced blood flow in the brain.

SPECT scans are specialised, so they are not frequently used. They are highly effective in showing injured regions of the brain, especially after a severe brain injury has been sustained. It is also used in cases of epilepsy to identify the location of the seizure. SPECT scans can also provide additional information to help with planning surgeries and long-term treatments.

After receiving a **radiotracer**, you will be asked to lie on the scanner bed, and the SPECT machine will rotate around your head to collect 3D images of your brain. The **radiotracer** will leave your body within a few hours. You might be advised to drink plenty of fluids to flush the radiotracer out quickly.

Functional magnetic resonance imaging (fMRI)

fMRI is a special type of MRI scan. It uses the same MRI scanner and methods to take images of internal parts of the body. fMRI looks at brain activity by measuring blood flow. The main difference between MRI and fMRI is that while MRI takes static images of the brain's structure, fMRI can identify which areas of the brain are active under different conditions.

fMRI scans are mainly used to investigate disorders of consciousness. This can be helpful in planning long-term treatments and to monitor brain activity.

fMRI scans have the same procedures and risks as MRI scans, as they are conducted using the same machine. fMRI scans may involve you doing tasks while lying inside the scanner, such as moving fingers, reading or thinking about specific things. Because of this, an fMRI scan can take longer than an MRI scan.

Waiting for your scan/ test results

Waiting for your results from a scan or test can make you feel anxious. However, it is important to remember that analysing any scan or test results can be a lengthy and complex process, and different tests and scans will rely on different types of analysis. It can therefore typically take a few weeks for any test results to come back.

If you have still not received your results after a few weeks, and have received no further information about them, contact your doctor, nurse or neurologist to ask about them.

Your doctor or consultant might show you the results of your scan, or alternatively you might wish to request a copy of it. Either way, it is your legal right to apply for access to your medical records that will contain the results of your scan. Information about this is available on the NHS website at www.nhs.uk/using-the-nhs/about-the-nhs/how-to-get-your-medical-records.

Interpreting your scan/ test result

Your GP or neurologist should interpret your scan results and discuss this with you. There may be medical terms that you are unsure of, and you should be able to ask for these to be explained to you. The Headway helpline might also be able to explain some medical terms, however they are not able to interpret scan/ test results or provide a diagnosis.

It is important to remember that, while brain scans can be helpful with diagnosing

or monitoring brain injury, they do not always reveal injury, especially if it is widespread or mild. Scan results should not, therefore, be considered as the only means of diagnosing brain injury. If a scan comes back clear and you are still concerned about possible symptoms of brain injury, you should seek support from your GP. Information for GPs on diagnosing brain injuries is available from our publication *Management of acquired brain injury - a guide for GPs*.

Conclusion

This publication offers information on the main scans and tests that are carried out after a brain injury, from first arriving at the emergency department to follow-up investigations. It is hoped that this information will reassure you and your family if you are referred for any of these scans or tests.

Remember that different hospitals will have different facilities. Therefore the scan that you are referred to will depend on the type of investigation needed as well as what is available in your area.

Always speak to your doctor or specialist for individual advice or if you have any further questions or concerns about a brain scan that you have been referred to.

Glossary

Combination scan - a combination of two scans done together to get a clearer picture of the brain, for instance a CT scan done with a PET scan is known as a PET-CT scan

Contrast dye - a temporary dye introduced to the body's bloodstream through an injection that improves visibility of specific organs when used in combination with CT and MRI scans

Electrode - a small piece of metal or other substance that can collect electrical activity. Electrodes used in EEGs measure the natural electrical activity of the

brain and send it to a computer to be processed in order to record brain activity. Electrodes do not emit any electricity and they are not painful.

Radiographer - a technician who is specifically trained to perform medical scans and deliver radiotherapy to patients

Radiologist - a medical doctor who specialises in diagnosing and treating illnesses that use medical imaging techniques

Radiotracer - a mildly radioactive substance, administered through an injection, that highlights areas of activity in the brain when used in combination with PET and SPECT scans

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