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The Spinal Column-Spinal Cord Injury Manual

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Regional Spinal Cord Injury Center of the Delaware Valley

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Spinal Cord Injury Manual

A publication of the Regional Spinal Cord Injury Center of the Delaware Valley

The Regional Spinal Cord Injury Center of the Delaware Valley provides a comprehensive program of patient care, community education, and research. It is a federally designated program of Thomas Jefferson University and its affiliated institutions of Thomas Jefferson University Hospital and Magee Rehabilitation Hospital.

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Spinal Cord Injury
Patient-Family Teaching Manual

A Publication of the
Regional Spinal Cord Injury Center
of the Delaware Valley

Researched and prepared by the clinical personnel of Thomas Jefferson University Hospital and Magee Rehabilitation Hospital

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Dedication

The Handbook Committee of the RSCICDV gratefully acknowledges the assistance and dedication of all who contributed to this manual, and all the others who worked so hard to make this Handbook a reality.

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Spinal Cord Injury

Spinal Cord Injury

The Spinal Column

The spinal cord is a part of a system called the *central nervous system*. The central nervous system is made up of two main structures — the brain and the spinal cord. The spinal cord is delicate tissue protected by spinal bones, which are called vertebrae. The spinal cord sits in a space through the center of the vertebrae called the spinal canal. The vertebrae are stacked one on top of another. The job of the vertebrae is to provide support and flexibility for the body and to protect the spinal cord. Discs separate the vertebrae. Discs are tough fibrous material that contains a thick fluid. The job of the discs is to act as shock absorbers or cushions so that movement throughout the back will not be painful.

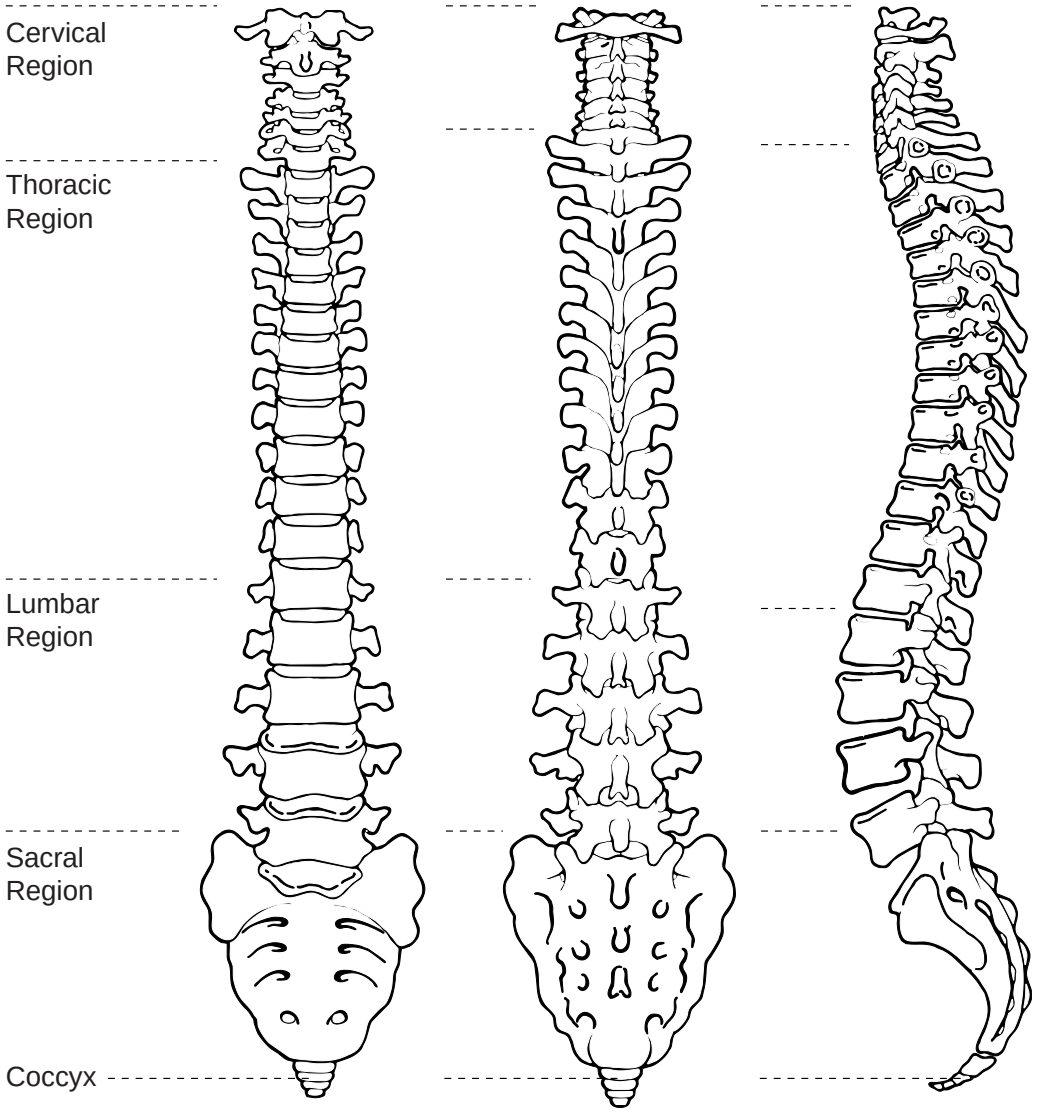
The vertebrae are connected to each other with a system of ligaments. These ligaments help the spinal column to remain straight, as well as give it the ability to twist and turn. When a spinal injury has occurred, often times there is damage to the ligaments.

It is not uncommon for the vertebrae to be injured and the spinal cord to be fine. However, the spinal cord can be injured with or without injury to the spinal column.

There are thirty vertebrae. The spinal column is divided into sections. These sections are similar to the segments of the spinal cord. These segments are:

- **Cervical:** 7 vertebrae (neck)
- **Thoracic:** 12 vertebrae (rib cage)
- **Lumbar:** 5 vertebrae (mid-back)
- **Sacral:** 5 vertebrae (lower back) (These bones fuse and become one.)
- **Coccyx:** 1 vertebrae (“tailbone”)

Three Views of the Vertebrae



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The Spinal Cord

The spinal cord is the largest nerve in the body. Nerves are "cordlike" structures made up of many **nerve fibers**. The spinal cord is made up of many nerve fibers.

The spinal cord acts as a telephone cable connecting the brain with other parts of the body. If you think of the spinal cord as a telephone cable, it connects the main office (the brain) to many other offices (different parts of the body). Messages are sent through the spinal cord in two directions.

- Messages from the body go to the brain by way of the spinal cord to give it information about **sensations**, such as touch, position sense, temperature and pain.

OR

- Messages from the brain go to the body by way of the spinal cord to create movement.

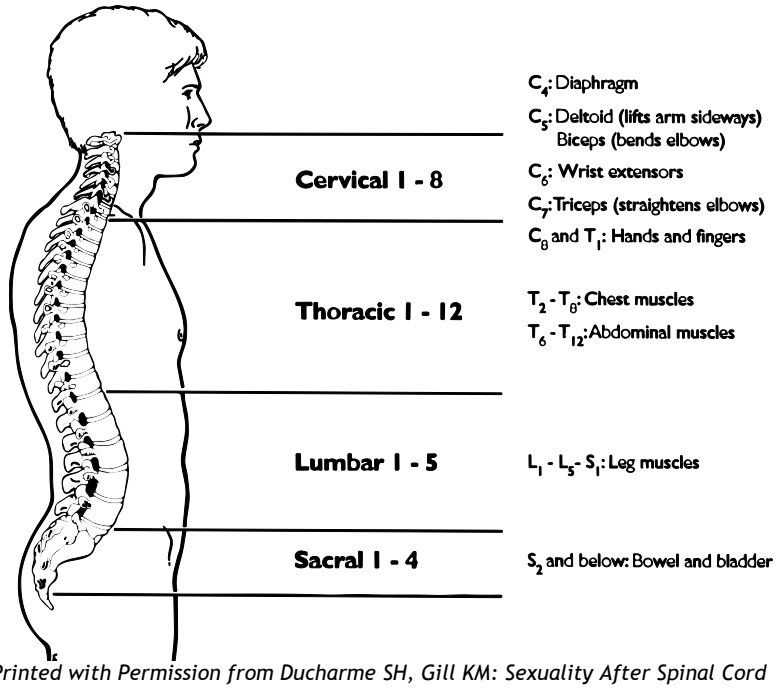
The spinal cord is about 18 inches in length (1 1/2 feet long). It starts at the bottom of the brain and goes to about your waist. The nerves that make up the spinal cord are called **upper motor neurons**. These nerve fibers are a part of the central nervous system. There are also nerves, which branch off the spinal cord all the way up and down the cord. These nerves are called **lower motor neurons**. The lower motor neurons exit between two vertebrae and go out to all parts of the body. At the point where the spinal cord ends (near the waistline), the lower motor nerve fibers continue down through the spinal canal to the sacrum or tailbone.

There are a total of thirty-one pairs of lower motor neurons. These nerves come from the different areas of the spinal cord and control different areas of the body. The nerves have the same name as the vertebrae from which they pass through.

The breakdown of the nerves is as follows:

- **Cervical (neck):** 8 nerves
  Control the neck, arms and hands.
- **Thoracic (trunk):** 12 nerves
  Controls the trunk and upper abdominal muscles.
- **Lumbar (lower back):** 5 nerves
  Controls the abdominal and upper parts of the legs.
- **Sacral (lower back):** 5 nerves
  Controls the lower parts of the legs, bowel, bladder and sexual function.
- **Coccyx (tailbone):** 1 nerve
  Provides sensation to the bottom of the spinal column.

The Spinal Cord and Corresponding Nerves



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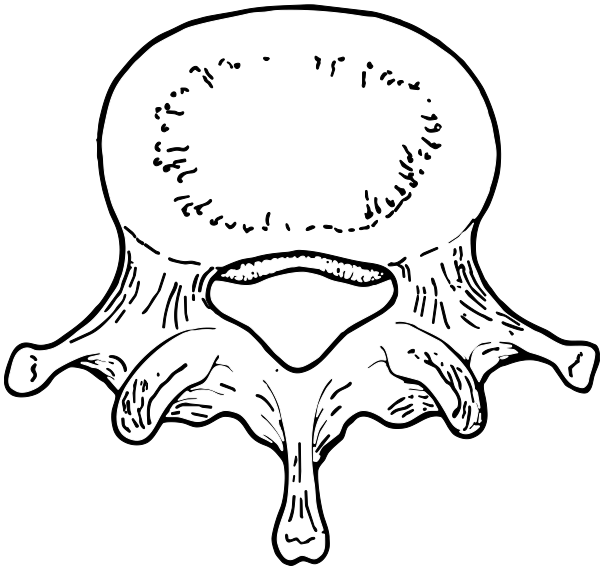
The Spinal Cord After Injury

A spinal cord injury can occur either from trauma or from a disease. In most spinal cord injuries, the vertebrae pinch the spinal cord. The spinal cord may become bruised or swollen. The injury may actually tear the spinal cord and its nerve fibers. An infection or disease can produce the same results. It is important to know that the spinal cord does not have to be cut in half for severe injury to occur. Unfortunately, right now we know that the spinal cord cannot heal itself once damage has occurred. However, depending on the way that the damage occurred, such is with bruising or swelling, you may experience some neurologic recovery. This recovery can include changes in sensation, the ability to move muscles or both. The amount of recovery can vary from person to person.

If you look at the diagram, you can see that there is not much room for the spinal cord to move within the bony canal. If a piece of bone or disc moves into the space for the spinal cord, it

can put pressure on the spinal cord and may cause it to bleed or swell.

Vertebrae Segment



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After a spinal cord injury, all the nerves above the level of injury keep on working the way they did before the injury. Below the level of the injury, the spinal cord nerves cannot send messages between the brain and parts of the body like they did before the injury. This happens because the area of injury disconnects the two parts of the spinal cord.

Diagnosing a Spinal Cord Injury

Once the doctor thinks that a spinal cord injury may have happened, he or she will conduct several tests to confirm this. The first test is a neurologic test. The doctor will ask you to move different parts or muscles of your body. He or she will ask you if you can feel different types of sensations, such as pinprick, touch or the position of your joints. The doctor will also take x-rays to show where along the vertebrae the damage happened. A Magnetic Resonance Image (MRI) may be ordered to show where and how much damage has occurred to the spinal cord. An MRI is a special type of x-ray that allows you to see where the damage occurred in the spinal cord.

All of this information is used to determine the diagnosis that the doctor will make. Each person's injury and the outlook for recovery are different. A person's injury is described by the type and level of injury.

Complete vs. Incomplete

When the doctor does a neurologic examination, one of the things that he or she is testing for is whether or not the person has a complete or incomplete injury. The doctor will test all of your muscles and different types of sensation to see which areas are still working. From this information, the doctor will classify your spinal cord injury by type.

There are two types of spinal cord injury. An injury is classified as complete or incomplete. A complete injury can be described as a cutting off all of the telephone service to a building. No messages can reach the offices. An incomplete injury is like stopping telephone service to some offices in a building, while keeping the service to other offices in a building. The amount and type of messages that can pass between the brain and other parts of the body will depend on how many nerves are **not** damaged.

Some people with an incomplete injury may have a lot of feeling but very little movement. Other people with an incomplete injury may have a lot of movement but only a little feeling. Incomplete spinal cord injuries will be very different from one person to another because different nerve fibers are damaged in each person's spinal cord.

When an incomplete injury has occurred, there may or may not be improvement in function. The improvement that a person with an incomplete injury gets is from changes in the function of nerve fibers that temporarily may not have been working due to swelling or bruising. This process may occur rapidly or very slowly, depending on each person's injury. Remember that no two spinal cord injuries are alike! Many people assume that "complete" means the spinal cord is completely severed and "incomplete" means that it was only cut partially. The terms complete and incomplete are used to describe functioning of the spinal cord, not the physical damage to it.

Tetraplegia (Quadriplegia) or Paraplegia

People who have suffered a spinal cord injury are also described as having *tetraplegia (quadriplegia)* or *paraplegia*.

A person is said to have paraplegia if he or she has lost feeling (sensation) and is not able to move parts of his or her trunk and legs. This type of injury happens when the spinal cord is injured in the thoracic, lumbar or sacral area. If you go back to pages 2-3 and 2-4 and review which areas control which muscles, you will see that depending on where the person's injury has occurred, he or she will have lost the ability to control different areas of his or her body. Someone who has had an injury in the thoracic area of his or her spinal cord will generally lose the

function of more muscle groups than someone who has had an injury to the sacral area.

A person is said to have tetraplegia (or you may have heard the word quadriplegia) if he or she has lost feeling (sensation) and movement in the arms, trunk and legs. This type of injury happens when the spinal cord is injured in the cervical or neck area. Again, if you go back to pages 2-3 and 2-4 and review which areas control which muscles, you will see that depending on where the person's injury has occurred, he or she will have lost the ability to control different areas of their body. Someone who has had an injury in the C4 area of the spinal cord will generally lose the function of more muscle groups than someone who has had an injury to the C7 area.

Sometimes the spinal cord is only bruised or swollen. As the swelling and bruising go away, the nerves **may** begin to work again. Unfortunately, at this time, there are no tests that the doctor can perform to tell us how many nerves, if any, will begin to work again. We do know that the longer there is no change in function, the less likely it is that there will be improvement. If a little recovery does occur, there is more hope. There is no guarantee that more function will return just because some does.

Some people may have involuntary movements, such as a twitching or shaking movement. These movements begin to happen a few weeks to a few months after the injury has happened. They are called *spasms*. Spasms are not necessarily a sign of recovery. The person cannot control these movements. Spasms happen when an uncontrollable message from the nerve causes the muscles to move. Spasms are not usually painful; however, it does take some time to get used to your body moving without you controlling it.

Spasms are helpful to people, because they help to maintain muscle tone. Also, they can be used in functional tasks if you are able to set one off and control it. A big increase in spasms (or *spasticity*) also acts as a warning system, letting you know when there may be a problem somewhere below your level of injury, where you may not be able to feel. For example, there is often an increase in spasticity when you have a urinary tract infection or even something as minor as an ingrown toenail. Spasms can be a problem if they wake you up in the middle of the night or cause pain.

Besides the effect that a spinal cord injury has on your ability to move and feel, your respiratory system may not work as it did before your injury. There may be change in your ability to

control your bowel and bladder, and there may be a change in sexual function. During your time in the hospital, the rehabilitation team will work with you to help you learn how to take care of your body and learn new ways to manage your needs. Many of the other chapters in this book will help you to understand how your injury has affected different parts and functions of your body.

Spinal Surgery

You may wonder why you need surgery if it cannot "fix" your spinal cord. Surgery is done for two reasons. One reason is to remove the pieces of vertebrae and disc that may be putting pressure on the spinal cord and nerve roots. The second reason is to stabilize the bony spinal column so that it will not move and put pressure on the spinal cord.

You may have heard the terms "*stable*" or "*unstable*" injury or spine. The neurosurgeons and orthopedic surgeons will decide which type of injury you have and how to best manage your injury. They will use the neurologic tests, x-rays and magnetic resonance images (MRI's) to help them decide the best way to handle your injury. Again, remember that no two injuries are ever the same, so what is decided for your injury may be different from what is decided about someone else's injury.

In stable injuries, only the vertebral body is fractured. The ligaments that hold the vertebrae in a line are not injured. Many stable injuries do not need surgery. If you have a stable injury that does not need surgery, many times you will be put into a brace to help the fracture heal and prevent the spine from moving too much. In cervical injuries (injuries to the neck area), this brace may be a halo or a cervical collar. In injuries to the thoracic or lumbar spine, the brace that is used is a plastic body jacket (clamshell or TLSO), or a prefabricated trunk brace. Further information about these braces begins on page 2-10.

An unstable injury to the spinal column is one where the ligaments have been damaged. This causes the vertebrae to come out of the alignment that they normally have and put pressure on the spinal cord. The bony spinal column is put back into alignment and then held in place (or stabilized) using a combination of bone (that is taken from your hip or leg), metal rods, springs and screws. The specific procedure that is used will depend on your particular injury.

Whether you have a stable or unstable injury, your surgeon will decide how long you must wear the brace. This decision is made based on the type of injury that you had, the extent of the

surgery involved and how quickly you heal. Different types of x-rays will be taken so that the surgeon can see the healing process and decide when the brace can be removed. Generally, you will be in your brace from two to four months.

How Do Muscles and Nerves Work Together?

The muscles of our body need the nerves to work in order for them to move. The nerves provide the signals from the brain to the muscles to get them to move in different ways. The muscles are what allow us to move.

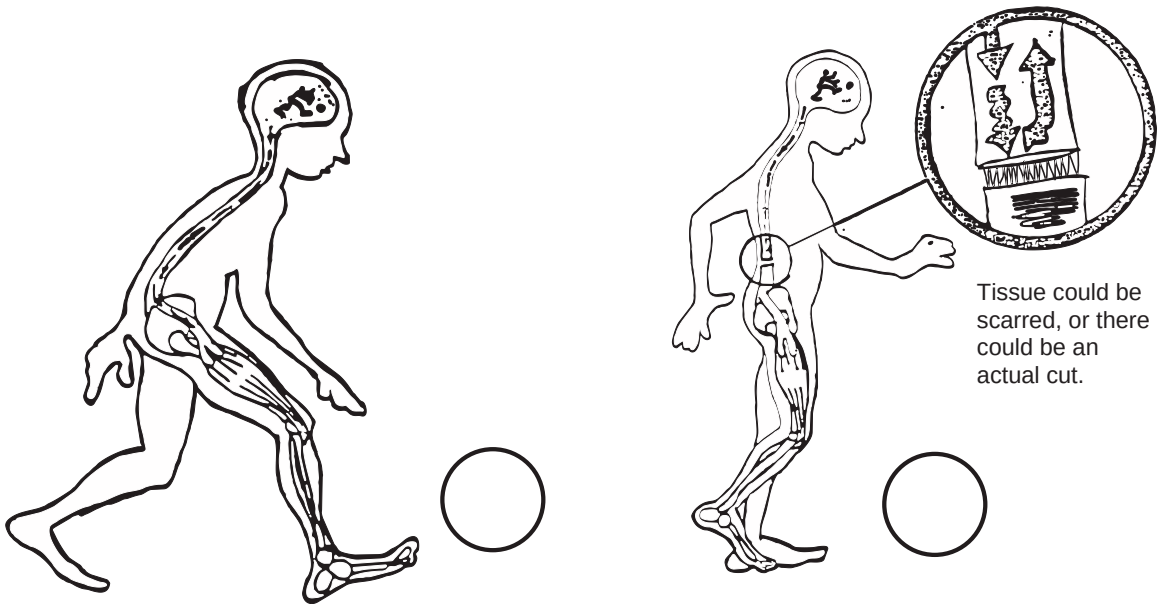
Muscles move the bones in our body, allowing us to do various tasks. Each joint in our body has the ability to move in different ways. Some joints move in a backward and forward motion, while others are able to move in circles. Bones are unable to move without the muscles providing the power.

The muscles are made of special tissue that can be stretched or contracted. Muscles are attached to the bones near joints, allowing for movement. The muscles are arranged in opposing groups, so that as one muscle contracts, the other one stretches.

"Normal" muscles are said to be under **voluntary** control. For example, if a person decides to kick a ball:

- The brain sends a message down the spinal cord to nerves in the leg muscles causing the muscles to contract, allowing the person to kick the ball

Kicking a Ball



When the spinal cord is injured, messages cannot get through to the nerves. Voluntary control of the body's movement is lost. For example, you may try to tell your leg to move to kick the ball, but although you are thinking it, the message doesn't get through to the nerves and muscles of your leg.

Halo Brace

The purpose of the halo brace is to hold your neck and head in proper position until your spinal column and the ligaments heal. The halo is the strongest immobilizer we have to prevent movement in your neck that might cause the spinal column to flex (move forward), extend (bend backward) or rotate (twist). The halo also provides support to your neck muscles.

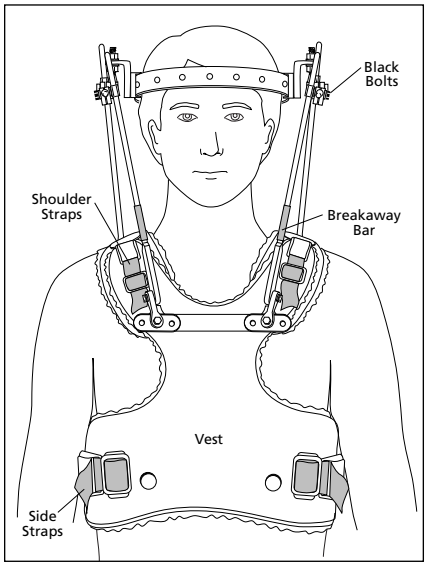
By using a halo brace, you are able to get out of bed sooner and move about. This helps to prevent some complications that could make you have to be in the hospital longer.

The halo brace is made up of three parts:

1. A metal ring with openings for the skull pins. The ring is usually made of titanium, but can be made of other metals.
2. An adjustable metal framework, which connects the ring to the plastic vest.

3. A plastic vest with a washable liner to support the framework.

Halo Brace



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Dos and Don'ts While in a Halo

While you are in a halo, there are some things that should never happen. These include using the framework to be turned or transferred. You should not get out of bed without having the framework of the vest checked, the buckles on the vest closed, and the pins tightly screwed into your head. The halo can be opened to check for skin problems and to change liners only when you are flat in bed. No one should try to tighten the pins of the halo, unless it is your doctor or person they designate. You should always have a liner in place when the vest is closed. Never wear any shirt underneath the vest. And never put any lotion or cream on your skin underneath the vest.

You should let your doctor or nurse know if you have neck pain, a headache or are able to move your head (even just a little). These are all signs of the halo not being properly adjusted. If the pins are loose, you should stay flat in bed until they are tightened.

And yes, you may take a shower and wash your hair in your halo, once your doctor has cleared you. The shower may be given lying down on a shower cart or sitting up in a shower commode chair. Your skin should be washed with soap and water and dried well.

Care of the Halo Brace

Daily care of the halo should include checking the pin sites, checking your skin for pressure areas and checking the vest to make sure that all the nuts and bolts are tight.

Halo Pins

There are four halo pins called skull pins, which hold your head and neck in place. Twice a day, the pin sites should be checked for redness, swelling, pain and drainage. If any of these symptoms occur, you need to tell your doctor or nurse. The nurses and therapists will ask you if you are able to move your head. This tells them if the halo is on correctly and the pins are tight. The pin sites are cleansed twice a day as directed by the surgeon. Hair around the pin sites should be kept short.

Halo Pin and Bolt Adjustments

Nurses and therapists will check the pin sites, nuts and bolts on the framework on a regular basis. Any loose nuts or bolts should be reported to the staff as soon as possible, since this could affect the alignment and lead to complications. Any loose pin will be tightened or removed and replaced by your doctor or designated staff.

Skin Care

Your skin should be checked twice a day by a nurse; in the morning before getting dressed and in the evening when getting undressed. You should be laying flat in bed before the vest is opened. To open the vest, the nurse will release the buckles or Velcro ® straps. The nurse will check as much of your skin as possible and may need to use a flashlight to see well. Should you have a reddened area, a pad may be placed over it. This will help to decrease the pressure that the vest is placing on the skin. The pad should be removed daily in order for the nurse to check your skin and when you shower. The same pad may be reused for several days.

The liner of your vest is replaced after you shower. Once you are sitting up, the nurse should check to make sure there is no bunching or creasing of the replacement liner.

Care of the Halo Liner

You should always have two liners for your halo — the one you are using and a spare. Your liner should be changed after every shower and more frequently as needed.

You can wash the liner with a mild soap and water. Rinse it and thoroughly dry it prior to reusing. Do not dry the liner by placing it on heating vents, using a blow dryer or putting it in the clothes dryer. Lay the liner on a flat surface and let it air-dry.

Cervical Collar

The purpose of the cervical collar is to hold your neck and head in proper position until your spinal column and the ligaments heal. The collar helps to prevent movement in your neck that might cause the spinal column to flex (move forward) and extend (bend backward). The collar also provides support to your neck muscles and may be used after a halo brace has been removed while you are working on strengthening your neck muscles.

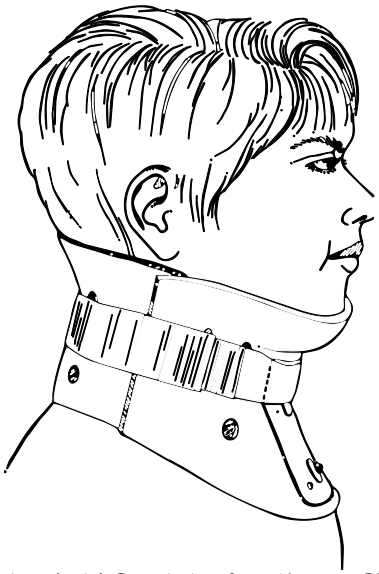
The collar is usually made of hard plastic. It can be removed by opening the Velcro ® straps. The collar can be wiped clean with a damp cloth and then dried. For people who have sensitive skin, have a heavy beard growth or who perspire a lot, the chin piece of the collar can be lined with a silk scarf.

The cervical collar has two pieces:

1. The front piece, which has a chin cup.

2. The back piece, which supports your occipital area (back portion of your skull).

Cervical Collar



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Clamshell (Body Jacket)

The purpose of the clamshell or body jacket is to stabilize the thoracic spinal column. It helps to prevent movement in your back that might flex (bend forward), extend (bend backward) or rotate (twist) the spinal column.

By using a clamshell, you will be able to get out of bed sooner and move about. This helps to prevent some complications that could make you remain in the hospital longer.

The clamshell is similar to wearing a plaster cast when you break an arm or leg. It is divided into two pieces, which hare held together by Velcro ® straps. The jacket is plastic and is lined with foam. Holes may be punched through the jacket and foam so that air can move. The jacket is made to fit tightly over your hips, chest and back.

Dos and Don'ts While in a Clamshell

While you are in a clamshell, there are some things that should never happen. You should not get out of bed before having the clamshell checked to make sure that it is on properly and that the buckles on the vest are closed. The clamshell can be opened to check for skin problems and to change T-shirts only when you are flat in bed. You should always have a tee shirt on when the vest is closed. And never put any lotion or cream on your skin underneath the vest.

Your clamshell can be removed only with assistance. Always ask for assistance in rolling when you are out of the clamshell. You must avoid twisting your spine. If your clamshell becomes too tight or too loose, please let your doctor, nurse or therapists know.

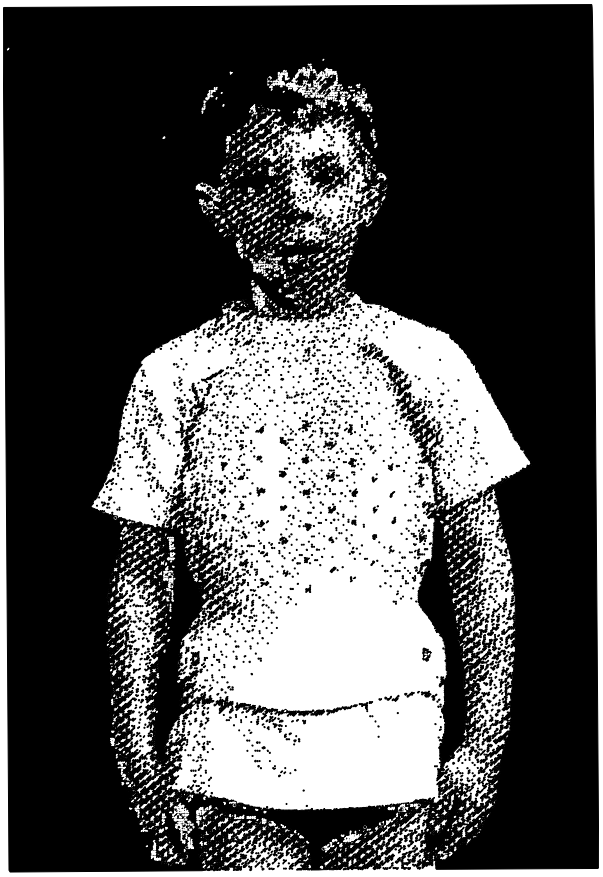
And yes, you may take a shower and wash your hair in your clamshell once your doctor has cleared you. The shower may be given while you are lying down on a shower cart or sitting up in a shower commode chair. Your skin should be washed with soap and water and dried well. Clamshell should be thoroughly dried before reapplied to your body.

It is wise to start sleeping in the clamshell as soon as your surgeon gives you permission. This will allow you to turn at night independently.

Care of the Clamshell

Daily care of the clamshell should include checking your skin for pressure areas and checking the vest to make sure that the Velcro ® straps fit correctly. You also need to make sure that the hard shell and foam are intact in order for the clamshell to fit correctly.

Clamshell



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How to Put On and Remove the Clamshell

To put the clamshell on:

1. Log roll on to your side. You will need assistance to do this. Do not pull yourself over. This can cause twisting of the spine.
2. Place the back piece of the jacket behind you. Make sure that the side portion of the jacket is under your side.
3. You can then be log rolled onto your back and into the jacket.
4. The front portion of the jacket is placed over your chest and held together by using the velcro straps.
5. The straps should be secured snuggly.

To put a T-shirt on:

1. After you have the back part of the clamshell on, pull your shirt over your head and arms.
2. Pull the shirt down in front.
3. After putting the front part of the jacket on, turn on your side.
4. Open the Velcro ® straps.
5. Pull the shirt down your back, making sure that the shirt is smooth.
6. Re-secure the straps.

When You Are Not Wearing the Clamshell

If you choose to sleep without the clamshell on or when you are changing your shirt, you must lie flat in bed. Do not raise the head of the bed. If you need to turn, log rolling must be done. Log rolling means that the upper and lower parts of your trunk (shoulders and hips) all move together; they are not twisted apart during the roll. In order to log roll correctly, you must have help in moving.

Since you may not twist or bend when you have the clamshell off, you may not be able to dress your legs without assistance.

Glossary

Cervical	The area of the spinal column and cord that is in the neck.
Coccyx	The area of the spinal column that is called your "tailbone."
Complete spinal cord injury	A spinal cord injury where there is no sensation or movement below the neurologic level of injury. Nerve impulses are not transmitted throughout the spinal cord.
Extension (extend)	To bend backward.
Flexion	To move or bend forward.
Incomplete spinal cord injury	A spinal cord injury where there is sensation, movement or both below the level of injury. Intact areas allow nerve impulses to transmit throughout the spinal cord.
Ligament	Soft tissue that connects two bones together.
Lower Motor Neurons	The nerves that branch from the spinal cord to the muscles.
Lumbar	The area of the spinal column and spinal cord that is in the waist region.
MRI (Magnetic Resonance Imaging)	A scanning or imaging test that allows specialists to see which part(s) of the spinal cord or other parts of the body has been damaged.
Neurologic level of injury	The lowest area of the spinal cord where sensation and movement are still detectable.
Occipital Area	The area on the back of your skull between the ridge and base of the skull.
Paraplegia	The result of an injury to the spinal cord in the thoracic, lumbar or sacral area, which results in a loss of sensation and movement in the trunk and legs.
Rotate	To turn or twist.
Sacral	The area of the spinal column and cord that is located in the small of the back.
Stable spine	An injury to the spinal column that does not affect the ligaments.
Tetraplegia	The result of an injury to the spinal cord in the cervical area, which results in a loss of sensation and movement in the arms, trunk and legs.

Thoracic	The area of the spinal column and cord that is located in the rib cage area.
Upper Motor Neurons	The nerves that make up the brain and spinal cord.
Unstable spine	An injury to the spinal column that results in damage to the ligaments, causing the vertebrae to shift.
Vertebrae	A series of bones located in our back, which provide support for standing, flexibility for bending and protection to the spinal cord.

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Comments and Feedback

The staff of the center has recently spent a lot of time and effort in revising this manual. However, we realize that those who are actively reading and using the manual can improve it. As a part of our program of continuous quality improvement, we ask you to help guide our efforts to improve the manual.

In the next section of the chapter are two forms. The first form is an overview by chapter that seeks to identify those areas of the manual that could benefit the most from additional work. We also seek to identify any major areas of concern that have not been addressed.

The second section is a more focused questionnaire that has as its goal the specific items that should be targeted. For example, should an item be added to the glossary or the definition changed. Should a drug be added to the discussion of bowel programs?

The more specific the comments are the more likely that we will be able to make the improvements that form the basis of your idea. By communicating with the Regional Spinal Cord Injury Center of the Delaware Valley, however, users grant us permissionto use any information, suggestions, ideas, drawings or concents communicated for any purpose we choose, commercial, public or otherwise, without compensation or acknowledgement whatsoever.

Thank you for taking the time to assist us in improving this manual.

Sincerely,

SCI Manual Committee

Regional Spinal Cord Injury Center of the Delaware Valley
Thomas Jefferson University Hospital
132 S. 10th Street
375 Main Building
Philadelphia, PA 19107

Feedback Form

Rate each chapter by placing an "X" on the scale underneath the term that best captures your opinion. Using the next page, provide specific comments regarding your ratings. Feel free to make copies of the next page.

	No Opinion	Fair	Satisfactory	Good	Excellent
Credits / Front Matter					
Table of Contents					
Introduction					
Spinal Cord Injury					
Bladder					
Bowel					
Respiratory					
Respiratory Dependent					
Skin					
Cardiovascular					
Nutrition					
Activities of Daily Living					
Equipment					
Mobility					
Psychology					
Vocational Services					
Recreational Therapy / Resource Guide					
Travel and Transportation					
Sexuality					
Spinal Cord Injury Follow-Up Care System					
Master Glossary					

Suggestions and Comments

Chapter: _____

Page(s): _____

Comments: _____

_____

_____

Any terms that need to be added to the glossary? How would you define the terms?

Any section or paragraph that was not clear?

Any drawing or sketch that would help to illustrate the material being covered?

Any additional topic that should be covered?

Any questions you have that you feel should have been answered by the manual?

What is the question?

What is the suggested answer?

Any references that should be added? Any other resources that should be mentioned?

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