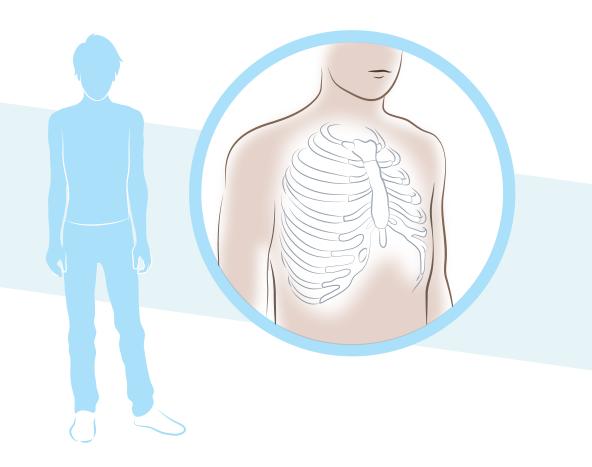
A GUIDETO PECTUS EXCAVATUM & CARINATUM



This booklet will help you understand your options if you have pectus excavatum or pectus carinatum.





Chest Wall Anomaly Centre - The Shriners Hospitals for Children Canada and the Montreal Children's Hospital.

We would like to acknowledge the financial support of the Mirella and Lino Saputo Foundation, Chair in Pediatric Surgical Education and Patient and Family-Centered Care, Department of Pediatric Surgery, McGill University Faculty of Medicine.

We would also like to thank our former patients, their families, and others for their feedback.

Design, layout, illustrations: Han Han Li Illustrations © 2022 Han Han Li Editing: Karen Brown/Media Meducom

This document is copyrighted. Reproduction in whole or in part is strictly prohibited. © Copyright August 2022. Chest Wall Anomaly Centre - McGill University Health Centre. 1st Edition



IMPORTANT

This booklet is for information only. It does not replace the advice of your doctor nor substitute for medical care. Always follow your doctor's advice.







Table of contents

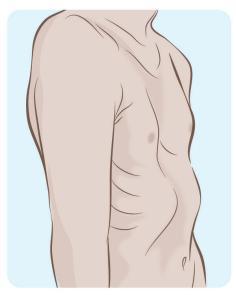
27 Parking

Introduction to pectus excavatum and pectus carinatum How to use this book 3 What is pectus excavatum (PE)? What is pectus carinatum (PC)? 7 Non-surgical options for PE/PC 9 Exercises for PE or PC 9 The brace for PC The vacuum bell for PE 12 Surgical options for PE/PC 14 What is a Nuss procedure? 14 What happens during the surgery? 16 Other questions you may have about the surgery 20 Exercises 25 Resources 26 Hospital map

Introduction

If you have pectus excavatum (PE) or pectus carinatum (PC), you have a condition that affects the chest area. Normally, the ribs, sternum (breastbone), and cartilage tissue develop so that the sternum is flat.

In PE, the sternum is sunken in.



In PC, the sternum is pushed out.

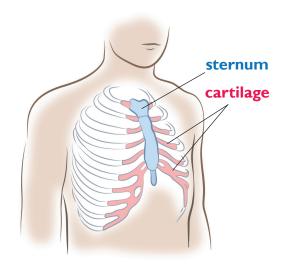


What causes PE and PC?

We do not know exactly why this happens.

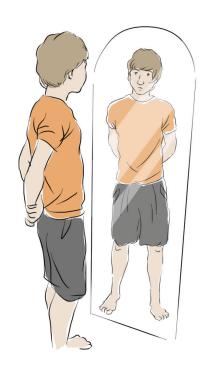
It is possible that the **cartilage** between the ribs and sternum did not develop properly.

(Cartilage is a **connective tissue** that is softer than bone but harder than muscle. It makes up parts of our noses, ears, and joints.)



Is it serious?

Sometimes PE may be serious, but not often. You may have obvious health effects or not. Even if PE or PC do not affect your health, it can affect how you look and feel about your body, and we know that this is important to you.



Can it be treated?

Everyone's chest is different. You may be in the normal range and may not need surgical treatment. Your doctor, in consultation with you, may suggest some treatment options. Then, we will help you decide what treatment may work best for you. No matter what you decide, we will look for solutions to help you feel healthy and good about yourself.



How to use this book

This booklet will explain your:

- condition (pectus excavatum or pectus carinatum)
- options (surgical and non-surgical)
- expectations after surgery how you might feel, what it might look like if you choose to do the surgery
- exercises and good habits to learn no matter what you decide

Review this booklet with your family. If you are not sure that surgery is right for you, speak with us. Ask us any questions about your options and what to expect.

If you choose not to have surgery, this booklet describes non-surgical options (brace or vacuum bell), exercises and other things you can do to improve your condition.

If you decide to have surgery, we will give you a surgery booklet that will help you prepare and recover from your procedure. You will be part of a program called a **care pathway**.

The goal of this program is to help you recover quickly and safely.

Research shows that patients will recover faster if they do the things described in this guide. There are instructions on eating and drinking, physical activity, and controlling your pain.

If surgery is right for you, bring the surgery booklet with you when you go to the hospital on the day of your surgery.

Use it as a guide during your hospital stay. Hospital staff will review it with you as you recover and before going home.

We know that having surgery can be stressful for patients and their families. Remember that you are not alone. We will support you every step of the way. Please ask if you have any questions about your care.

What is pectus excavatum (PE)?

Pectus excavatum (PE), also known as sunken chest or funnel chest, is an irregularity of the chest area where the **sternum (breastbone)**, **cartilage** and **ribs** are caved in. The condition can be present at birth or develop early in life. Most patients will notice their PE during adolescence, at the beginning of their growth spurt.

PE often begins as a small dent and becomes more noticeable as children grow.

What causes it?

We do not know what causes pectus excavatum.

We do know that boys have this condition more than girls. Some people also have a family history of PE or PC. Patients with other conditions, like scoliosis, Poland's syndrome, or connective tissue disorders such as Marfan's syndrome, have a higher risk of also having PE.

What are the symptoms?

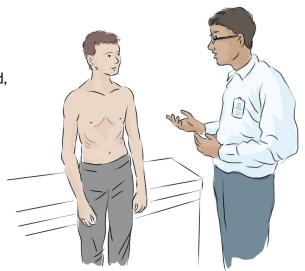
Most children and teens have no symptoms. Some have:

- · breathing problems when active
- pain in the chest area (while resting or after exercise)
- heart problems (for example, palpitations)

Teenagers with a more serious condition may limit sports activities, have problems socializing, or become withdrawn.

How is it diagnosed?

A medical exam is all that is needed to diagnose PE. No other tests such as a CT scan or echocardiogram are needed for diagnosis. However, doctors may use these imaging tests for other reasons: to see how much of the chest is affected, decide if you need an appointment with another specialist, or help plan surgery. Other tests such as pulmonary function may be useful sometimes.



How is it treated?

Your doctor may suggest different treatment options. These will depend on:

- how much your PE affects your chest area
- your age (your doctor may wait until puberty to decide which treatment is most appropriate)
- how you feel about your condition

Most people with this condition will have follow-up appointments to see if there are any changes over time. If the situation worsens or as a patient moves into puberty, a different decision may be made. Decisions are always shared with patients and parents. You will have a lot to contribute to what treatment is best for you.

Here are the main treatment options for PE:

Exercise

Your surgeon may suggest exercises to improve your posture and build up your chest wall muscles. These are useful for all patients.

Vacuum bell

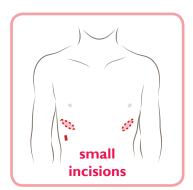
This treatment is used if you

- have a mild condition, or
- are not interested in surgical correction, or
- are too young for surgical correction.



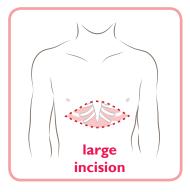
Surgery – the Nuss procedure

This is minimally invasive surgery. This means that the surgery uses small cuts instead of one large cut to open the area (see picture). It is for patients whose condition affects their quality of life. The procedure uses a metal bar inside the body, under the sternum, to fix the shape of the chest area. The bar is removed 2-3 years later.



• Surgery - the Ravitch procedure

This is **open surgery**. This surgery uses one large cut to open the area. It is a more complex type of surgery that involves removing some cartilage (connective tissue) close to the ribs and moving the sternum to correct the shape of the chest. This procedure is rarely used for PE.



What is pectus carinatum (PC)?

Pectus carinatum (PC) is also known as raised chest or pigeon chest. If you have this condition, the chest wall pushes out as you grow. Patients with this condition have a raised sternum (breastbone) and cartilage (connective tissue). Mild cases can happen in early childhood, but in most cases, PC is only noticed when children have their growth spurts at puberty.

What causes it?

We do not know what causes pectus carinatum. Boys have this condition more than girls. Some people also have a family history of PC or PE. Patients with other conditions, like scoliosis, Poland's syndrome, or connective tissue disorders such as Marfan's syndrome, have a higher risk of also having PC.

What are the symptoms?

Most people with this condition do not have symptoms. For most people, the biggest problem is how they may feel about how it looks.

Some people do feel some discomfort around the deformity.

How is it diagnosed?

Like PE, your doctor can usually make a diagnosis based on a medical examination. No tests are needed.

How is it treated?

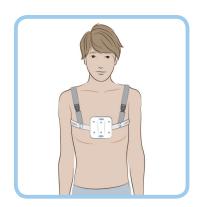
There are different ways to treat PC. Here are the main treatment options:

Exercise

An exercise program can improve your posture and build up your chest wall muscles. In some cases, gaining muscles and fat may make it less noticeable.

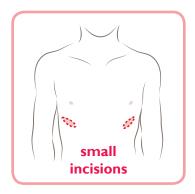
Brace

Most people can be treated with a brace. This puts pressure on the chest to flatten it gradually over several months.



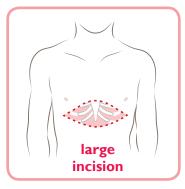
Surgery – reverse Nuss or Abramson

This is a **minimally invasive surgery**. This means that the surgery uses 2 small cuts instead of one large one to open the area (see illustration). The procedure corrects the problem by placing a metal bar under the skin and over the sternum. This squeezes down the chest and reshapes the chest area. The bar is removed 2-3 years later.



• Surgery - the Ravitch procedure

This is **open surgery**. This surgery uses one larger cut to open the area. This type of surgery involves removing the abnormal cartilage while keeping its lining intact. The breastbone is moved to its normal position, and over the following months, the cartilage regrows so that the chest shape and strength become normal.



Non-surgical options for PE/PC

Exercise for PE or PC

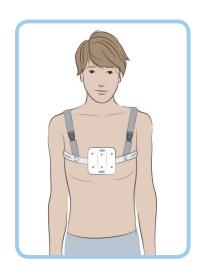
Exercise is good for all patients since it can improve your posture and build up your chest wall muscles. A list of exercises is in the last section of this booklet. Your health care team can help you choose the ones best for you.

The brace for pectus carinatum

The **brace** is a device that helps to **flatten the chest** so that it is closer to a normal shape. It does this by putting pressure on the chest bone and cartilage. It works the same way that braces are used to correct uneven teeth. We recommend this if you are bothered by the way your chest looks.

The brace is **custom-fit** for you and adjusted by an orthotist (this is a specialist for braces). Your treating team will explain when and how to wear it.

Here is what else you need to know if you are thinking about getting a brace.



Do I have to wear it all the time?

In the beginning, we recommend that you wear it day and night. You can take it off for showering or during physical exercises such as gym class or swimming.

What if I don't want to sleep with it or wear it at school?
 Some patients have difficulty sleeping with it. Others don't want to wear it at school. But you will get faster results the more you wear it.

Many teenagers wear the brace under their shirt at school without anyone noticing.

How old do I have to be to use a brace?

Bracing can be done at any age, but the best time is before or during your growth spurt. At the end of the growth spurt, the chest wall gradually becomes stiffer, so the bone and cartilage are more difficult to remodel.

Will I have follow-up appointments?

Yes, you will have regular appointments with the orthotist for adjustments. The first one will be after I month. You will also have follow-ups with the doctors from the Chest Wall Anomaly Clinic.



When will I notice any changes?

In most cases, there is a noticeable change within 2-3 months.

How long will I have to wear it?

That depends on a couple of things: the type of protrusion, the stiffness of the chest wall, and how much you wear it. For most patients, it will take 6-12 months. Once you and your health care team are satisfied that your condition is corrected, there is a 3-4 month period of maintenance. You will wear the brace 12 hours a day (either day or night) during this time.

When do I take off the brace? What happens after?

We will remove the brace when your doctor agrees. The final step is to take end-of-treatment measurements and pictures. You will keep the brace at home in case it is needed later.

If the sternum starts to stick out again, we will readjust the brace and start the treatment again. This happens in a small number of cases. Even so, it usually gets better after bracing again.

We will usually ask you to come back to the clinic after I year for a final followup. If the situation is stable after I year without bracing, you can return the brace to the clinic.

Are there any side effects?

Yes, there are a few side effects. Fortunately, they are easily managed.

- Early on, there can be some discomfort from the pressure on your chest. You may feel that it is difficult to take a deep breath.
 - Our team prevents these problems by limiting the amount of pressure applied by the brace. We readjust the brace regularly as the protrusion gradually gets smaller.
- Another common problem is redness on the skin where the brace applies pressure.
 - To deal with skin redness, we sometimes adjust the padding of the brace.
 - Acne can also worsen under the brace. Some prefer to wear a T-shirt or undershirt under the brace, while others prefer to wear it directly on the skin.

The vacuum bell for pectus excavatum

The **vacuum bell** is a device that (like a vacuum) creates a negative pressure that **pulls out the sternum** towards a more normal shape. It can be useful for patients:

- with a mild to moderate pectus excavatum
- who are too young to undergo surgery
- who don't want to have surgery

There are different sizes and shapes of vacuum bells. Sometimes after using the smaller size for 2-3 years, we have to switch to another size.



Do I have to wear it all the time?

The vacuum bell works best if you wear it at least 2-4 hours a day and 7 days a week. We start with 15 minute periods and gradually increase to at least 2-4 hours. Wear it during quiet times. Take it off before any physical activity (it will come off on its own if you don't remove it). Many will wear it when they are studying. Some will even go to bed with it.

When will I start noticing the difference?

After a few months, the sternum may start to stay flat right after the bell is taken off. It will usually stay like this for a short time before gradually sinking back in. Over time, for most patients who wear it daily, the depth gradually decreases.

How long will I have to wear it?

Most people have to use it for a few years. It may not give a perfect correction but may make your chest closer to normal.

Will I have follow-up appointments?

Yes, regular follow-ups should be at least every 4 months for the first year, more often if necessary.

Are there any side effects?

Yes, but they are generally mild and easily treated. Early on, the feeling of the sternum being pulled out creates some discomfort. We can usually solve this by using less vacuum.

All patients will notice some purple discoloration of the skin while wearing the device. This is normal and gradually goes away after removing the vacuum bell. Some **petechiaes** (blood droplets being sucked through the skin) may appear if too much pressure is applied. If that happens, hold off for a couple of days and gradually restart using less vacuum. This will usually solve the problem. You can use this same treatment for **seromas** (accumulation of fluid under the skin).

The most common problem is that patients do not use it every day or not enough hours a day, so it does not work.

Surgical Options for PE/PC

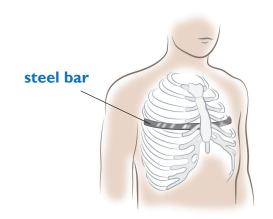
What is a Nuss procedure?

The Nuss procedure is a surgery that corrects the chest wall by **inserting a metal bar in the body**, behind or in front of the sternum (when the bar is placed in front, we call this a reversed Nuss or Abramson procedure).

Why do I need this procedure?

The most common reasons for having the procedure are:

- abnormal appearance of the chest
- shortness of breath with exercise and loss of endurance
- heart problems



What happens during the surgery?

Repair of Pectus Excavatum (Nuss procedure or Minimally Invasive Repair of Pectus Excavatum - MIRPE)

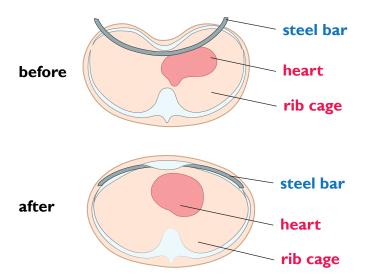
During surgery, the surgeon:

- makes two small incisions, one on each side of the chest.
- places a small video camera (a thoracoscope) through another small incision on the right side. This allows them to see inside the chest.
- inserts a specially designed steel bar through the incisions. The bar goes under the sternum and rests above the side ribs. This bar is shaped for your condition.
- removes the scope and closes the incisions at the end of surgery.

If you would like to watch a video of the Nuss procedure, you can view it here: https://youtu.be/mduyxaQ3mmw

How does the bar work?

• The bar lifts the sternum by putting pressure under the sternum and against the ribs on the side.



Repair of Pectus Carinatum (Abramson procedure, reverse Nuss technique or Minimally Invasive Repair of Pectus Carinatum - MIRPC)

- In a few cases, minimally invasive repair of Pectus Carinatum (MIRPC) is performed. In this case, the procedure is similar to the above, except the **steel bar** is placed underneath the skin of the chest, **over** the sternum. Wires passed around the ribs on each side help to keep it in place.
- If you would like to watch a video of the reverse Nuss procedure, you can view it here: https://youtu.be/y44ht1ZzVhw

If you are having a Ravitch procedure, your surgical team will explain how your chest area will be reshaped. Each case is different.

Other questions you may have about the surgery

How long will the surgery take?

Most Nuss procedures take I to I $\frac{1}{2}$ hours, but you may be in the operating room for 2-3 hours, depending on the procedure. The time includes putting you to sleep (anesthesia) and preparing for surgery. The Ravitch procedure takes longer.

Will it hurt?

After surgery, your chest area will feel sore. Patients sometimes describe the pain as a heavy weight pressing on the chest.

Fortunately, we can control the pain with medicine and other methods. The anesthesiologist will give you medication before the surgery, during the surgery, and after to help lessen your discomfort. The acute pain nurse will also see you every day to check on your pain. If needed, we can change your medication plan.

To help keep the pain under control, you may get an epidural or intravenous medication. Another technique, cryoablation of the intercostal nerves, allows us to reduce the need for strong painkillers and the length of stay in hospital. Your surgeon will explain how this works.

The acute pain nurse is also trained in **integrative medicine**. This includes breathing exercises, self-hypnosis and guided imagery to help you get through the pain.

You will also get a prescription for pain medication when you leave the hospital. This includes instructions for how much you should take and when. Once you are home, continue to take the pain medications as directed. Also, use the pain management techniques that work best for you.

What else can I expect?

You may become constipated after surgery. This means that you may have a hard time having a bowel movement (making a poop). You might also feel stomach pain. Pain medications can cause constipation, so this is to be expected. The health care team will encourage you to do things that will help get your bowel movements back to normal. This includes drinking liquids, sitting up and moving around after surgery, and including fibre and other foods in your diet. Your doctor will also give you medication to help manage your constipation.

How long will I have to stay at the hospital?

Most people will have to stay in the hospital for at least 2-5 days, depending on the pain treatment they receive and their recovery.

Patients who receive intercostal nerve cryoablation* can often leave after I or 2 days.

*Cryoablation is a technique that minimizes pain by deep freezing the chest wall nerves. The frozen nerves stop sensing the pain, but gradually regrow in the following months.

How long will it take to recover?

On average, it takes 4-6 weeks or more to recover. Generally, you will be out of school for 2 weeks after you return home. You will not be able to do contact sports for about 3 months and may have to adjust your activity level. See "When can I go back to school?" & "Activities – When can I start gym class or play sports?" for more information. Follow the advice from your health care team and do your exercises after surgery. This will help you recover properly.

How long will I have symptoms after surgery?

Everyone is different. Symptoms related to your chest condition should get better over time. For example, the pain gradually improves, and by 2-3 weeks after surgery, you may only need acetaminophen (e.g. Tylenol) or ibuprofen (e.g. Advil) from time to time. If you had breathing issues before, they should also improve within a few months after surgery.

· How will my chest look after the surgery?

Your chest will look a lot better. You will have small scars that will not be obvious after the Nuss procedure. The scar is more visible after the Ravitch repair, but the chest area will become flatter.



Is surgery right for me?

You, your family, your surgeon and possibly your health care team should discuss your options for treatment. Together, you can decide what is best for you.

Most of the surgeries we describe here are minimally invasive. But even if the procedure is minimally invasive, there are some related risks and complications. Your surgeon will discuss these risks with you.

Will I have support after surgery?

Our team is available to help you and support you throughout the process. If you have any questions or concerns, contact us.

What is the steel bar made of?

It is made of stainless steel.

What if I am allergic to stainless steel?

If you have a stainless steel allergy, we use a different metal, called titanium.

What if I have more questions.

If you are not sure and have more questions about whether you should have the surgery, please contact the team. They can also put you in touch with other teenagers who have had the operation. Speaking with others may help you decide which option is best for you.

y questions? Write them down here.					

Exercises

These exercises and good habits can improve your posture and build up your chest wall muscles. Follow these 10 basic exercises and/or the plan given to you by your physiotherapist.

I. Correct sitting posture As frequently as possible

Sit tall with your buttocks as far back in the chair as possible.

Keep your feet flat on the floor or on a footrest. Keep your shoulders back, chin tucked and maintain a small curve in your lower back. Tip: use a lumbar roll to keep the correct posture and avoid slouching.



2. Posterior pelvic tilt

Reps: 10

Lie on your back with your knees bent. Keep shoulders flat on the floor and breathe normally. Flatten the small of your back into the floor by activating your stomach muscles and buttocks (see picture b).

*Small of your back is the part of your back that curves the most (at waist level). Breathe normally and hold for 5 seconds. Relax. This is one "rep."

REMEMBER how to do this pelvic tilt for future exercises (plank, pushups, chest stretch).

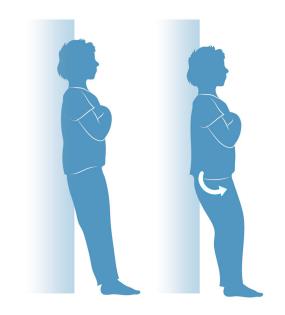




3. Pelvic tilt against a wall

Reps: 10

Stand with your back and shoulder blades against a wall. Bend your knees slightly, place your feet hip-width apart, slightly away from the wall. Breathe normally. Relax knees slightly and do a pelvic tilt by flattening your lower back to the wall (like the previous exercise, except this time you are standing). Keep shoulders back and tuck in your chin. Hold for 5 seconds while maintaining steady breathing. Return slowly to the initial position.



4. Hip hinge side bridge

Reps: 3 Hold: 20 seconds or longer

Lie on your side propped up on your elbow. Keep your elbow directly below your shoulder. Engage your core. Squeeze your buttocks and lift your hips up off the floor while pushing your hips forward (as shown).

You should end with your shoulders, hips and knees in a straight line. Hold for 20 seconds or more. In a slow and controlled manner, lower your hips down to the start position. Do this 3 times on both sides.





5. Abdominal plank

Reps: 3 Hold: 20 seconds or longer

You must be able to do a proper posterior pelvic tilt to do this exercise!

Place the elbows directly under the shoulders, with your upper body supported on your forearms.

Straighten your legs, tighten your abdominal muscles, and lift hips up, keeping your back straight (no sagging) and head aligned with the spine.

Hold the posterior pelvic tilt for 20 seconds or more. If your back begins to sag, stop the exercise, redo the pelvic tilt, and try again. If this position is too difficult, you can plank on your knees and forearms. Repeat 3 times.



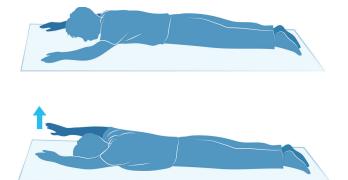


6. Lower trapezius activation

Reps: 10 Hold: 3 seconds

Lie face down with both arms extended (stretched out) at 45 degrees (like a Y). Keep your head down. Turn your thumbs up to the ceiling.

Lift your arms upward slightly, keeping elbows straight and shoulders lowered. Put a small, rolled towel under your forehead for comfort.

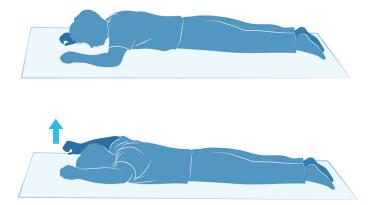


7. Middle trapezius strengthening

Reps: 10 Hold: 3 seconds

Lie face down with your arms at 90° from the body and elbows bent.

Lift both arms off the floor while pushing your shoulder blades together. Hold for 3 seconds. Lower your arms and repeat the exercise.



8. Push-ups

Reps: 10 suggested

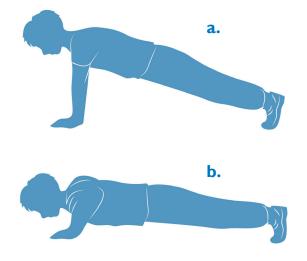
You must be able to do a proper posterior pelvic tilt to do this exercise!

Lie on the floor, face down with your hands wider than your shoulders

Do a pelvic tilt while looking at the ground, keeping your neck in line with the spine. Push up on hands and straighten elbows (Position a).

Slowly lower body while holding pelvic tilt. Do not let your back sag (Position b).

Keep your head in line with your spine. You do not need to go as low as the floor. The goal is to keep your back straight and maintain the abdominals engaged by doing the pelvic tilt. Try to do 10 sets.



9. Shoulder chest stretch

Reps: 4 Hold: 30 seconds

Face a corner. Stand straight with a good posterior pelvic tilt. Put your hands on the walls with your elbows at the height of your shoulders. Lean gently forward until you feel a medium stretch in your chest muscles. Hold for 30 seconds. Do not arch your back. Repeat.



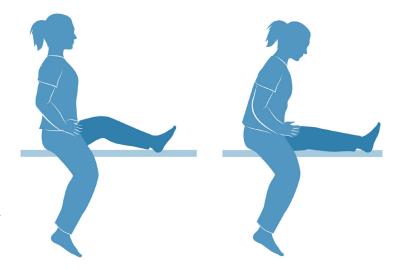
10. Hamstring stretch

Reps: 4 Hold: 30 seconds

Sit on a firm surface with a straight back, and one leg bent in front.

Slowly straighten your leg until you feel a stretch behind your thigh.
Hold this position for 30 seconds.

*You can lean forward without bending at the back (no round back) to increase the stretch. Relax.



Resources

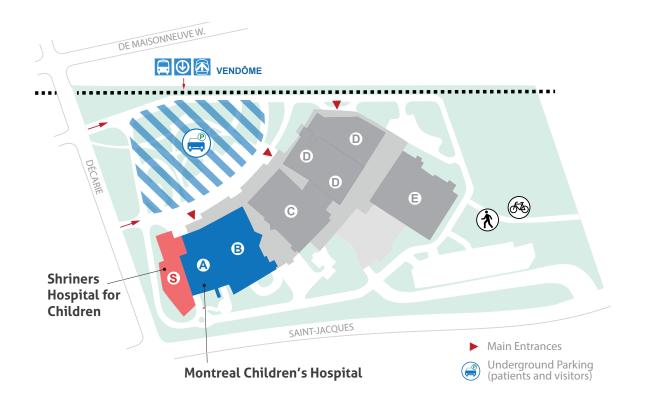
Websites of interest for Patients

For more about NUSS:

www.chop.edu/conditions-diseases/pectus-excavatum

- Video of Nuss procedure: https://youtu.be/mduyxaQ3mmw
- Video of Reverse Nuss procedure: https://youtu.be/y44ht1ZzVhw

Hospital Map



Montreal Children's Hospital

Shown on map as Blocks A & B
1001 Decarie Blvd, Montreal, Quebec H4A 3J1

Shriners Hospital for Children - Canada

Shown on map as S 1003 Decarie Blvd, Montréal, Québec H4A 0A9

Parking - Montreal Children's Hospital



Daily Rate

Less than 2 hours **FREE**2h - 3h59 **\$6.25**4-24 hours **\$10.25**

Parking Pass Rate

7 days **\$47** 30 days **\$94***

Parking Rate for Frequent User *

A frequent user is an out-patient who visits the hospital by car for their appointments or treatments at least ten (10) times per month.

* These parking rates do not apply to the staff nor its physicians.

* Certain conditions apply.

7 days **\$23.50** 30 days **\$47**

Unlimited entry and exit at the hospital where the pass was purchased. Certain conditions apply

10 visits (flexible) \$30

1 entry and 1 exit per visit, no expiry date

Where to Pay



By debit card or credit card Visa or MasterCard

Customer Service Parking Office



By credit card Visa or MasterCard **Barrier gate at exit** (hourly parking only)

Contact Us



Parking Service Desks

Montreal Children's Hospital

Location Extension
A RC.1000 23427



Parking - Shriner's Hospital

Free parking for our guests is underground at the P3A level in the 100 area. To get to the public parking area, guests must drive past all the hospitals, turn left onto the contour road and immediately turn left again into underground parking. The moment you are going down the ramp towards the parking, you must look up to see the signage, take a ticket at the wicket and follow the signage for Shriners Hospitals for Children — Canada all the way to P3A 100, where you will find the parking entrance directly into level SS2 of the hospital.

Families must bring their parking ticket to the front desk for validation. Once in the hospital through the SS2 doors, please take the elevators that you will find in the museum up to RC.

Important: the families of children treated at Shriners Hospitals for Children who wish to take advantage of the free parking must park in the underground parking in the P3A – 100 area. Free parking does not apply to the express parking outdoors.

https://www.shrinershospitalsforchildren.org/montreal/getting-here



