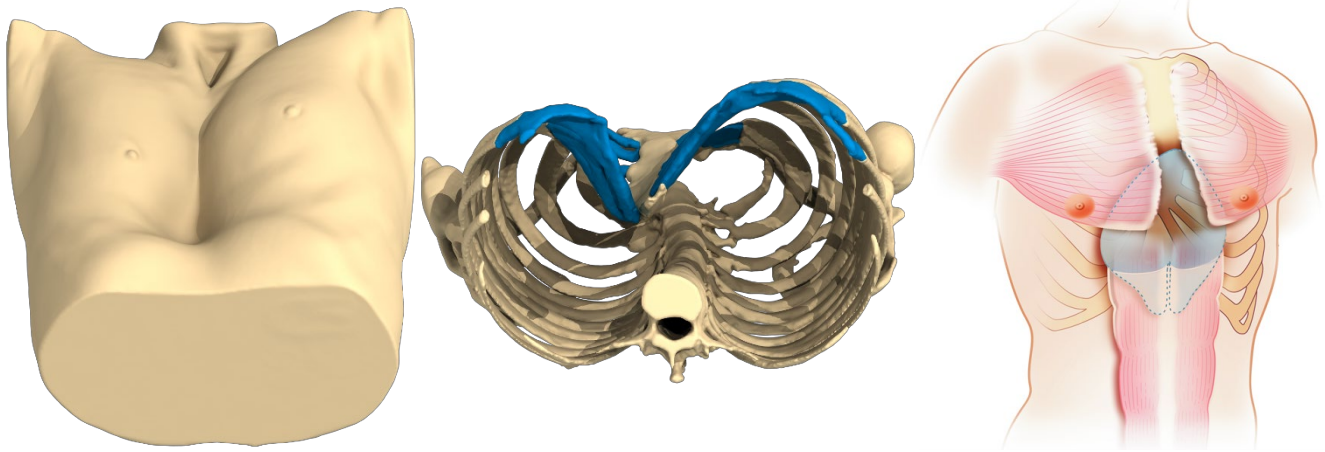


PECTUS EXCAVATUM

COMPUTER-AIDED SIMPLIFIED CORRECTION WITH CUSTOM-MADE SILICONE IMPLANT



DEFINITION, OBJECTIVES, AND PRINCIPLES

Pectus excavatum, or funnel chest, is the most common congenital thoracic deformity. It is characterised by a median sternum depression, most of the time with a great vertical axis, and by invagination of costal cartilages from the third to the eighth rib. It corresponds to a more or less significant sunken of the thoracic wall, with a decreased anteroposterior diameter of the thorax. It can be median or lateral, symmetrical or asymmetrical.

The occurrence of this deformity varies between 1/300 and 1/1000 births depending on the papers. Thus, this is a relatively common condition. The interview reveals a family history in about 37% of cases.

Cardiac or respiratory functional consequences are generally null or due to restricted physical activities induced by poor body image. The objective of this correction is purely morphological, or even aesthetical.

This deformity is often poorly accepted physically and psychologically by the patient, reflected by a modified self-confidence and by a malaise, which can be sometimes deep, leading to a true complex. Psychological consequences are often important from adolescence onwards, disturbing self-image, social relationships, and sometimes indirectly sporting activities.

Choosing a filling procedure with custom-made implant is more logical than a heavy orthopaedic correction of the anterior thoracic deformity (Ravitch or Nuss procedures).

The lipofilling procedure is possible for discreet forms, but is not enough for more pronounced forms, especially concerning young thin patients.



3D custom-made implants

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It is mandatory to wait the end of puberty to perform the intervention, i.e. 14 years old when the hormonal impregnation and the deformity are stable, even if growth is not over yet.

The thoracic implants currently used consist of a medical-grade silicone rubber or elastomer: there is no envelop or filling product. The risks of deterioration and breaking are non-existent. A fibrous exclusion envelop (capsule) is rapidly created, just like around any foreign body (steel, glass, nylon...), but there is never any rejection reaction, producing antibodies. This envelop cannot retract onto this incompressible implant: there is never any "retraction" (retractive capsulitis).

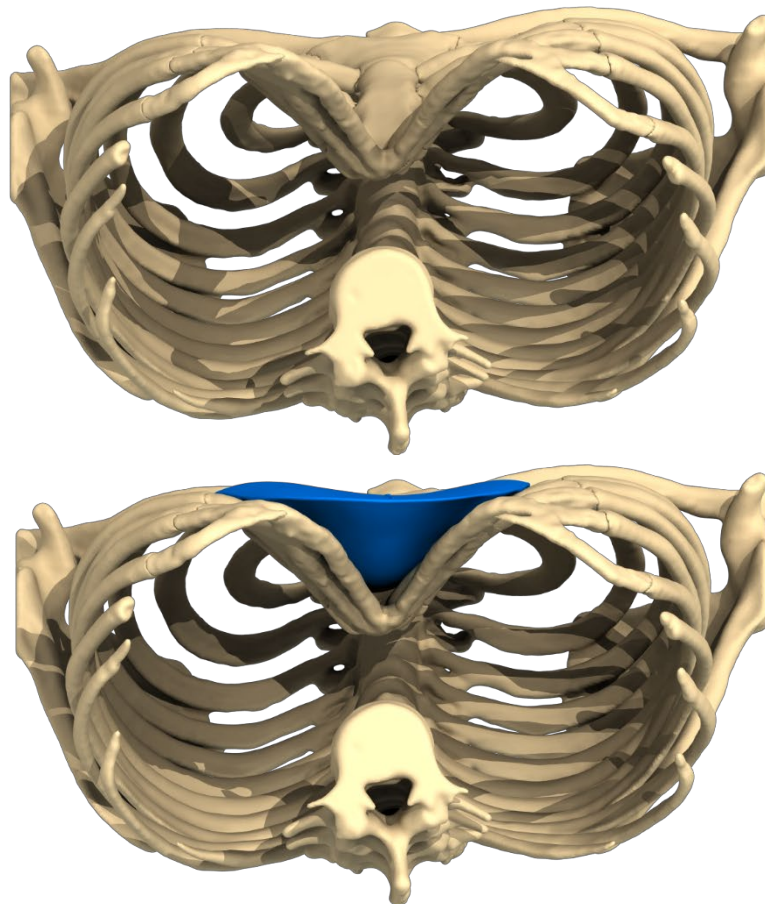
These implants are unique, specific for each patient and they are manufactured using computer-assisted design (CAD) from a quality CT scan (sections from 1 to 1.2mm).

Nevertheless, the implant is retained for the rest of the patients' life.

BEFORE THE SURGERY

A surgical consultation with clinical examination, will allow you to be informed of the different existing techniques. This consultation is associated to a 3D thoracic scan: CT acquisition of the entire chest, arms along the body on the back.

A pulmonary function test can be also done to rule out the rare contraindications and to check there are no functional disorders. Pictures are taken frontally and in 3/4 view.



Computer-aided design

TYPE OF ANAESTHESIA AND TERMS OF HOSPITALISATION

The intervention is performed under complete general anaesthesia with intubation in supine position; it requires a 3-day hospitalisation maximum (admission the day before the intervention and discharge the day after).

THE SURGERY

Preoperative drawing

The surgeon marks the median vertical axis of the thorax, the edges of the implant prototype, and its exact height position (scan reference points).

Skin incision

It is vertical, pre-sternal, of about 7cm, at the centre of the future locus, in the deepest area (where there is excess skin). It goes on directly until the sternal bony level.

Bilateral median pectoral disinsertion

Internal insertions of the pectoralis major muscle are released and the submuscular detachment continues until the edges of the locus drawn on the skin.

Opening the locus of the rectus muscles

In the lower epigastric area, the superficial aponeurosis of the rectus muscles of the abdomen is open horizontally on both sides of the white median line and the wall which separates both rectus muscles.

Implant insertion

The sterile implant, made from a 3D scan using computer-aided reconstruction and prototyping, consists of a medical-grade silicone elastomer or rubber. It is firm in its centre, in the thickest part, but increasingly smooth on the edges, which are tapered like an airplane wing. It is puncture proof, untearable and, unlike silicone gel breast implants, it has an unlimited lifespan.

It is located in its submuscular locus, prepared for its exact size, its lower pole slides under the aponeurosis of the rectus muscles, split and astride the intermuscular wall.

Thus, the implant is perfectly stable and cannot undergo any subsequent displacement, especially downwards.

Closing the wall

It is performed on three levels using absorbable suture material: - on the muscular level - on the subcutaneous level - intradermal stitches on the skin

Thanks to a rigorous and patient haemostasis, aspiration drainage does not need to be performed, which shortens the hospitalisation, the discomfort, and the risk of infection.

Compression

The intervention ends with a dressing and a circulatory compression using an elastic belt on a flexible roller made of Dacron felt, placed at the centre.





Medical-grade silicone elastomer sterile implant

AFTER THE SURGERY: POSTOPERATIVE OUTCOMES

Postoperative pain is most of the time short and controlled with grade 1 analgesics.

A thoracic compression bra with median pad needs to be worn night and day for a month.

The sero-haematic and then serous effusion is steady, due to the oedema in the locus in contact of the implant: it requires a puncture to evacuate from the day of discharge, and then every 8 days. Punctures are painless, and their number (from 2 to 5) depends of the thickness of the subcutaneous and muscular fatty layers.

Work stoppage lasts 15 days.

The complete and solid healing of the suture of the two pectoralis major muscles between them takes a year. The practice of sport is forbidden for 3 months and must be resumed in a progressive and non-violent way for one year. Sports involving sudden movements of the pectoral muscles, are not recommended for one year (push-ups, core-strengthening exercises, climbing, tennis, golf, contact sports, etc.).

As sutured together, the forced contraction of the two pectoral muscles could lead to a transverse movement visible under the skin. There is no functional discomfort or secondary atrophy, but patients practicing bodybuilding should be warned.

RESULT

Two to three months are necessary to appreciate the morphological result. It is the time necessary for the oedema to disappear and to improve comfort, which allows for a gradual resumption of sports activities. A whole year is necessary to assess the scarring is good and subtle.

Modern computer-assisted reconstruction techniques have increased the aesthetical results, mainly in very deep and/or asymmetrical forms, especially in women.

Correcting the deformity is in a vast majority of cases complete, definitive, and natural with a very satisfying anatomical restauration.



Before/After surgery in a man



Before/After surgery in a woman

POSSIBLE COMPLICATIONS

The correction of a pectus excavatum using a custom-made implant, performed mainly for morphological reasons, remains nevertheless a true surgical intervention, which involves risks associated to any medical procedure, however slight it may be.

Complications associated to the anaesthesia must be distinguished from complications associated to the surgical procedure:

- Regarding the **anaesthesia**, during the mandatory preoperative consultation, the anaesthesiologist will inform himself the patient of the anaesthetic risks. It should be pointed out that the anaesthesia induces reactions in the body which can sometimes be unpredictable and more or less easy to control. However, with a qualified anaesthesiologist-resuscitator, who practises in an actual surgical situation, the risks incurred become statistically very low. It is necessary to bear in mind that techniques, anaesthetics, and monitoring methods have greatly improved over the past thirty years, offering an optimal safety, especially when the intervention is performed outside of an emergency situation and in a healthy individual.
- Regarding the **surgical procedure**, when choosing a qualified and expert plastic surgeon, trained for this type of procedure, you limit the risks as much as possible, without eliminating them entirely though.

In practice, the vast majority of pectus corrections using custom-made implants, performed according to the rules, do not present any serious issue; postoperative outcomes are simple and most of the patients are totally satisfied with their results. Nevertheless, complications can occur following the intervention, some are inherent to the surgical procedure, and others are specifically related to implants:

Complications inherent to the surgical procedure

• Effusions, infections

- **Serous effusion**: this is not a complication since it is steady but transient: it requires 2 to 5 postoperative punctures with 8-day intervals.
- **Haematoma**: the excess of blood around the prosthesis is an early complication which can occur during the first hours. If the haematoma is major, revision surgery in the OR is thus preferable in order to evacuate the blood and to stop the bleeding at its origin; it is very exceptional if all the haemostatic precautions are taken, anticoagulants forbidden, along with trauma, especially an excessive and premature physical activity
- **Infections**: possible after this type of surgery. A deterrent antibiotic therapy is always prescribed during the intervention, it is not recommended after though.

• Cutaneous necrosis

It was observed on the suture line after an inopportune contact of the skin with the electrode of the electric scalpel; it requires an immediate excision and an increased monitoring since it can lead to the exposure of the implant through surgical wound dehiscence. Then, a revision surgery is necessary, with the risk to remove temporarily the implant.

• Healing abnormalities

Since the healing process involves somewhat random phenomena, sometimes scars are not, in the end, as discreet as desired, and might have very different aspects: wide, retractile, adhesive, hyper- or hypopigmented, hypertrophic (swollen), or even exceptionally keloid.

This is rare due to the excess skin and the low pressure upon closing.



- **Sensitivity modification**

The anaesthesia of the cutaneous area covering the implant is steady but regresses spontaneously in a centripetal manner in a few months.

Risks specifically related to custom-made silicone elastomer implants

They are non-existent, instead of flexible silicone gel breast implants

- No "folding" or "wavy" aspect
- No "capsula retraction"
- No rupture: the implant is retained for the rest of the patients' life.
- Malposition, displacement: Malposition or secondary displacement of implants is avoided respecting rigorously the surgical technique of retro-musculoaponeurotic installation and the choice of a custom-made computer-assisted conception.
- No long-term late periprosthetic seroma

ASSOCIATED BREAST HYPOPLASIA IN WOMEN

In case of asymmetry or associated breast hypoplasia, it is possible to consider implementing secondarily one or two breast implants, but mandatorily after a minimum of 6 months.

It is a submammary surgical approach and a premuscular position.

A request for prior agreement is mandatory.

If breast implants have already been implemented, they did not correct the median deformity. Most of the time, it is necessary to remove them temporarily or definitely depending on each case.

CONCLUSION

This is the information we wanted to give you in addition to the consultation. We advise you to keep this document, to read it again after the consultation, and to think about it later.

Then, you may have new questions, for which you will expect additional information. We are at your disposal to talk about it during a next visit, or on the phone, or even the day of the intervention when we see each other again, and of course before the anaesthesia.

Thank you for sending us your signed and dated written informed consent, mentioning you agree to:

- the presence of Pectus Excavatum and the absence of functional respiratory or cardiac disorders,
- the general anesthesia,
- the subpectoral placement of a silicone rubber implant,
- the vertical median scar of 7 to 9 cm,
- the disinsertion of the pectoral muscles then their suture to one another

PERSONAL NOTES



3D custom-made implants