

# Correction of pectus excavatum with substernal strut

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## Özet

### Pektus ekskavatumun substernal bar ile onarımı

1983-1998 yılları arasında 18 pektus ekskavatum olgusu substernal bar ile tedavi edilmiştir. Olguların çoğunda (13 olgu, % 72) ameliyat sadece estetik nedenler ile gerekli görülmüştür. % 28 olguda fizik aktivite kısıtlanması, % 11 olguda da tekrarlayan solunum yolu enfeksiyonları tariflenmiştir. Deformitenin derecesi "Hollow indeks" kullanılarak yapıldı. "Hollow indeks" iki olguda I, 11 olguda II, kalan beş olguda da III olarak saptandı. Onarım transvers cilt insizyonu kullanılarak, alt 4-5 kot kartilajının bilateral subperiosteal çıkarılması ile gerçekleştirilmiştir. Sternumun üst kısmında transvers "wedge" osteotomi yapıldıktan sonra substernal alan serbestleştirilip altından çelik bar geçirilmiştir. Ameliyata bağlı mortalite yoktur. Ameliyat sonrası komplikasyonlar; pnömotoraks (3 olgu), yara enfeksiyonu (1 olgu) ve seroma gelişimidir (2 olgu). Yeniden ameliyat gerektiren göğüs çökmesi hiçbir olguda olmamıştır. Çelik bar 6-9 ay sonunda çıkarılmıştır. Ortalama 3.6 (1-5) yıl izlemde estetik olarak olguların çoğunda (% 83) sonuç mükemmel, geriye kalan 3 olguda da iyi olarak değerlendirildi. Pektus ekskavatum düzeltiminde çelik bar kullanımı güvenli, kolay uygulanabilir ve mükemmel kozmetik sonucu ile hasta açısından da rahat bir yöntem olarak gözükmektedir.

**Anahtar kelimeler:** Pektus ekskavatum, substernal bar

## Summary

Between 1993-1998, 18 patients affected by pectus excavatum (PE) were treated with substernal strut. Most of the patients required operation for aesthetic reasons only (13 patients, 72 %). Exercise limitation was reported by 28 % and 11 % had frequent respiratory infections. The degree of the deformity was graded according to Hollow Index (HI). HI was I in two patients, II in 11 patients, and III in the remaining 5. Repair is performed through a transverse skin incision with the subperiosteal resection of the lower four or five costal cartilages, from sternum to the costochondral junction bilaterally. A transverse wedge osteotomy is made through the upper part of the sternum. The substernal space is mobilized and a stainless steel strut is placed across the lower part of the chest. Steel strut is sutured to the fourth or fifth rib bilaterally. There was no operative mortality. Complications included pneumothorax in three, wound infection in one, and seroma in two. There was no recurrent chest depression requiring reoperation. The strut was removed 6 to 9 months postoperatively. The majority of the patients (n=15, 83 %) were considered as excellent in terms of aesthetic results and 3 were good. The mean follow-up was 3.6 years (1 to 5 years). The substernal strut appears to be safe, easy to implant and to remove, and is comfortable for the patients with the excellent cosmetic results.

**Key words:** Pectus excavatum, substernal strut

## Introduction

Pectus excavatum (PE) is the most common form of chest deformity, usually diagnosed after birth. The main feature of the PE is depression of the anterior chest wall.

The degree of deformity may vary from a trivial depression with no functional impairment, to an extremely severe anatomic deformity that leads to mec-

hanical ventilatory insufficiency and, occasionally, to cardiac displacement and compression<sup>(9)</sup>. Most are not life-threatening lesions and produce limited functional abnormalities<sup>(15)</sup>. Numerous surgical techniques have been described for correction of pectus excavatum deformity. There is no doubt that each of these techniques have merit and in proper hands will provide satisfactory results.

Our personal experience has been the use of a substernal strut, offering satisfactory cosmetic results with minimal complications rates in repair of the funnel chest deformity.

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## Materials and Methods

There were 14 male and 4 female patients. The age at the time of operation ranged from 5 years to 13 years. The follow-up period ranged from 1 to 5 years (median 3.6 years). The most frequent complaint was related to the unattractive physical appearance of the defect (n=13, 72 %) (Figure 1 a,b).

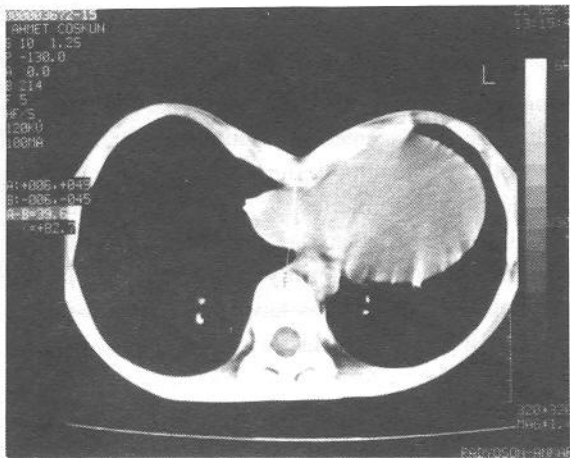


Figure 1 a) Preoperative external appearance, b) chest CT of a patient.

Mild to moderate exercise limitation was reported by 5 patients (28 %), most frequently in those older than 10 years. Three (11 %) had frequent respiratory infections.

The degree of deformity was graded according to Hollow Index, which represents the ratio between the amount of water contained in the chest depression with the patients in a supine position, and the body surface area <sup>(1)</sup>. The grade of PE was I in two patients, II in 11 patients, and III in the remainin 5. The area of chest depression was symmetrical and localized in 6 (33 %); symmetrical and diffuse in 10 (56 %), and localized or diffuse but asymmetrical in 2 (11 %).

In order to evaluate the overall results, a questionnaire regarding cosmetic appearance was submitted to the patients and relatives before surgery and at the time of follow-up. The results were judged as excellent in patients with normal morphologic features of the chest, unapparent scar, and patient satisfaction; good if a small deformity was still present or the scar was bothersome but the patient was satisfied, and poor if the patient was not satisfied because of residual or recurrent severe chest depression requiring reoperation <sup>(2)</sup>.

The operative technique used for all patients in the study is a modification of that described by Adkins <sup>(3)</sup>. A transverse skin incision is made midway between the nipples and costal margin with a slight upward bow in the center. Skin flaps are elevated over the pectoral fascia. The pectoral muscles are reflected laterally from attachments to the sternum and costal cartilages with electrocautery. The pericondrium is incised on the midanterior surface of the lower four to five costal cartilages bilaterally, extending from the costochondral junction to the sternum.

Abnormal costal cartilages are resected subperichondrally, carefully preserving perichondrium. The substernal space is mobilized and stainless steel strut is placed across the lower part of the chest. The steel strut is sutured to the fourth or fifth rib bilaterally. A transverse wedge osteotomy is made through the upper anterior face of the sternum. The pectoral muscles are sutured together over the sternum. After complete hemostasis is verified, skin is

closed with a subcuticular absorbable suture with adequate drainage of the substernal space. An intravenous antibiotic (ceftriaxone) is given for five days.

The patients are usually ambulatory by their third postoperative day and may leave the hospital by the sixth or seventh day subsequent to operation. The stainless steel strut is removed on an outpatient basis 6 to 9 months after repair with the patient under light general anesthesia. To remove the strut, a one centimeter incision is made immediately over the palpable end.

### Results

There was no operative mortality. Complications included unintentional pneumothorax in three patients (intraoperative), wound infection in one and wound seroma in two (postoperative) (Table I).

The majority of the patients (n=15, 83 %) were judged as excellent in terms of aesthetic results (Figure 2 a,b, Figure 3), 3 (17 %) were considered good. Exercise limitation disappeared after surgery. No recurrence of chest deformity was observed in any of the patients during the follow-up period.

### Discussion

The belief that this type of chest deformity is caused by an overgrowth of costal cartilage favors surgical intervention that will remove the cartilage involved. The most commonly performed procedure is that

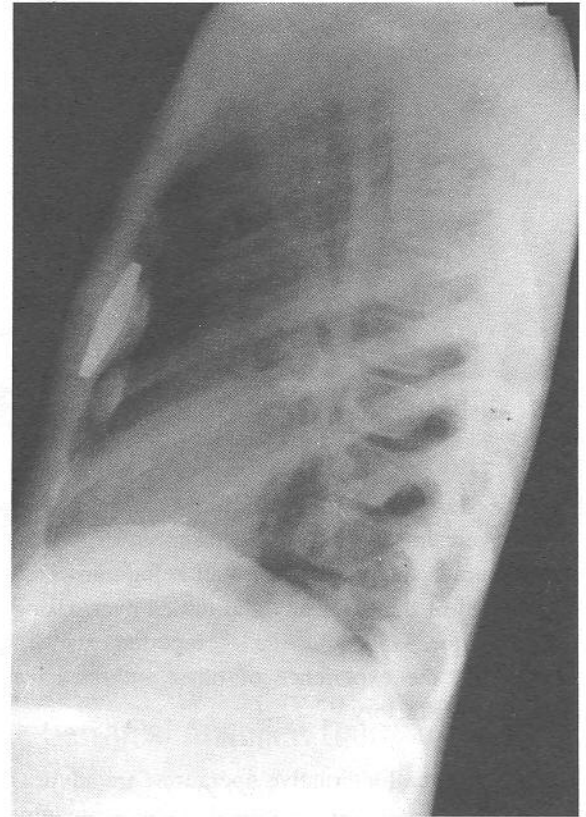
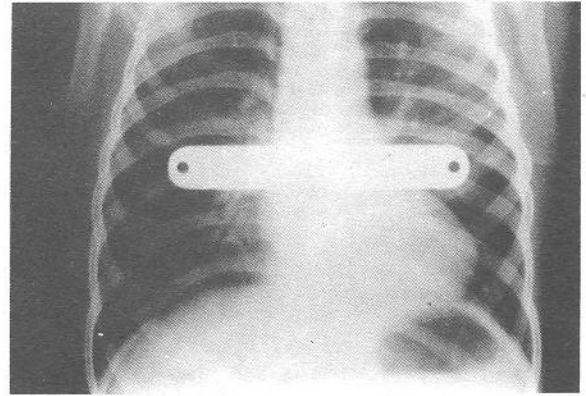


Figure 2 a). Postoperative posteroanterior, b) lateral roentgenograms 3 months after correction of pectus excavatum.

Table I. Patient profiles, complications and results

Sex	
Male	14
Female	4
Mean age (years)	7.4 (5 to 13)
Hollow index	
Grade 1	2
Grade 2	11
Grade 3	5
Complications	
Unintentional pneumothorax	3
Infection	1
Seroma	2
Results	
Excellent	15
Good	3
Poor	-

described by Ravitch<sup>(10)</sup> in 1965, where the affected cartilage is removed, and the sternum is freed the surrounding tissues and held in a somewhat overcorrected position by the surrounding soft tissues of pericondrium, muscles, and endotheracic fascia.

This technique does not require any internal or external fixation and has been widely applied for many years<sup>(14)</sup>. Its drawback is the incidence of recurrence due to the retraction of the soft tissues surround-



Figure 3. Postoperative external appearance of the same patient 7 months after correction.

ding the sternum <sup>(13)</sup>. This problem becomes even more severe in the case of sternal turnover, where the sternum is sutured in place after being transected at the level of the deformity and turned over. Using this technique, Wada and Ade <sup>(16)</sup> reported excellent results, but the experience of other authors have been less satisfactory <sup>(15,17)</sup>.

Therefore several alternative operations are advocated in which the sternum is provided with temporary postoperative support by a metal or resin strut <sup>(5,6)</sup>, Rehbein and Wernicke <sup>(11)</sup> developed struts that could be placed into the marrow cavity of the ribs at costochondral junction. Adkins and Blades <sup>(3)</sup> used retrosternal elevation by a metallic strut.

Innovations in these methods include bioabsorbable struts, Marlex mesh, or a Dacron vascular graft as a strut, but there is no evidence they are preferable to traditional methods and have generally been abandoned because of unsatisfactory results, patient discomfort and infection or implant extrusion, respectively <sup>(7,8,12)</sup>.

The basic features of the surgical repair used in our series of patients are similar to that advocated by Adkins and Blades <sup>(3)</sup>. The use of strut has allowed a more aggressive surgical repair and with strut stabilization, there is negligible paradoxical movement after operation, regardless of the number of cartilage segments resected.

Therefore, the requirement for postoperative analgesia medication has been reduced substantially in all patients. The patients are usually ambulatory by their third postoperative day and may leave the hospital by the sixth or seventh day.

Operative complications included unintentional pneumothorax in three patients, whom required the use of transpleural drainage for 24 to 36 hours postoperatively. Immediate postoperatively, a sternal wound infection was observed in one patient who was successfully treated by antibiotics and local antiseptics. Seroma or subcutaneous fluid accumulation was observed in two patients after the removal of drains and necessitated needle aspiration during the first week of operation.

The final contour of the chest wall was excellent in the majority of the patients. All subjective symptoms, when present, dissappeared after surgery.

In our experience, the correction of PE using a substernal strut gives good results in terms of cosmetic appearance and overall morbidity. The results are durable and the recurrence of chest deformity is virtually absent.

The substernal strut is safe, easy to implant and remove and comfortable for the patient. We conclude that this technique has proved reliable for pectus excavatum over a wide range of patient ages.

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