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How to do it? / Nasıl yapılır?

A new surgical approach for mixed-type pectus carinatum: the Onen procedure

Miks tip pektus karinatuma yeni bir cerrahi yaklaşım: Onen yöntemi

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In this article, a new surgical approach applied to eight cases which show pectus excavatum and carinatum features was discussed. Nuss method was used for pectus excavatum deformities, while resection and reconstruction with a titanium mesh and screws were used for pectus carinatum deformities. This lately defined method was named as Onen procedure.

Keywords: Nuss; pectus carinatum; pectus eskavatum.

Bu yazıda pektus ekskavatum ve karinatum özellikleri gösteren sekiz olguya uygulanan yeni bir cerrahi yaklaşımı tartışıldı. Pektus ekskavatum deformitelerine yönelik Nuss tekniği kullanılır iken, pektus karinatum deformitelerine yönelik rezeksiyon ve rekonstrüksiyon için titanyum mesh ve vidalar kullanıldı. Yeni tanımlanan bu cerrahi teknik Onen yöntemi olarak adlandırıldı.

Anahtar sözcükler: Nuss; pektus karinatum; pektus ekskavatum.

Pectus excavatum (PE) and pectus carinatum (PC) are the most common congenital chest deformities. While PE is seen once per 400 births and PC is observed once (1) per 1,400 births, mixed-type chest deformities occur at a lower rate (0.14%)[1,2] and contain characteristics of both PE and PC (Figure 1). Although there are many classification types that have been created in accordance with the morphological features of pectus deformities, the classification recommended by Willital et al.[3] is the one that is accepted the most in clinical use (Figure 2). In mixed-type deformities, PE is found more often in the xiphoidal process of the sternum, whereas PC is seen at the higher levels of the sternum usually at the manubrium sterni. Chondromanubrial-type PC can be either symmetrical or asymmetrical. If PE less severe, it is generally classified as a type of PE. Classifying pectus deformities is important for determining a proper treatment plan, and with that in mind, we performed the new, minimally invasive Onen procedure on eight patients with mixed-type pectus. In this procedure, we combined Wang's reconstruction procedure, in which titanium mesh and screws are used to correct PC deformities, with the Nuss procedure, which is normally used only for PE deformities.

To the best of our knowledge, this combination has never been performed before, but it is a viable technique since it does not require a long hospital stay after the operation and the patients can return to work or school after only a short period of time. Herein, we describe the procedure in detail and provide our patients' satisfaction ratings for this new surgical method.

PATIENTS AND METHODS

We operated on eight patients (4 females, 4 males; mean age 21 years; range 18-24 years) at our clinic with mixed-type chest deformities categorized as types 6 and 8 according to the Willital classification system. According to the results of a pulmonary function test (PFT), the forced expiratory volume in one second (FEV_1) values of the patients, who were not diagnosed with any abnormal electrocardiography (ECG) findings in the preoperative period, were 2.5±0.4 liters (minimum: 193; maximum: 3.20), whereas their forced vital capacity (FVC) values were 3.1±0.5 liters (minimum: 2.40; maximum: 4.00). They did not have any symptoms arising from their deformity except for exercise intolerance in the preoperative period; however, three patients were preoperatively

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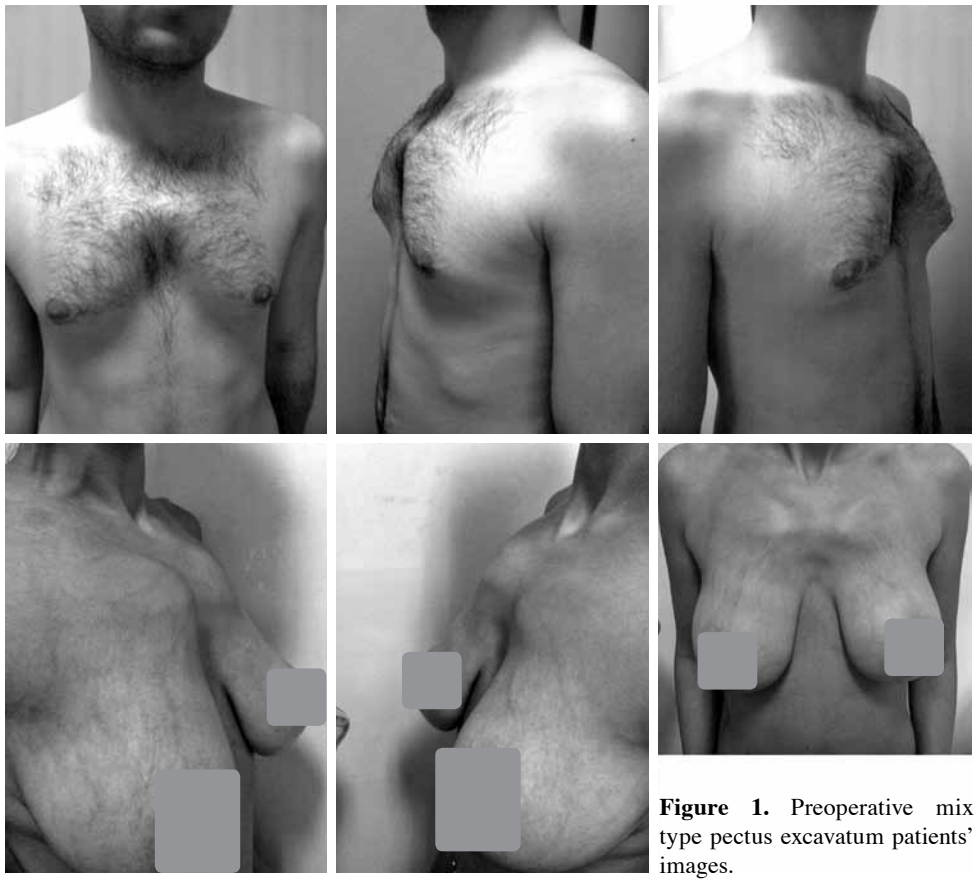

Figure 1. Preoperative mix type pectus excavatum patients' images.

diagnosed with cardiac displacement resulting from cardiac pressure on three-dimensional (3D) computed tomography (CT).

The same surgical approach was performed on all eight patients in order to repair the pectus deformities, which were documented with images taken in the

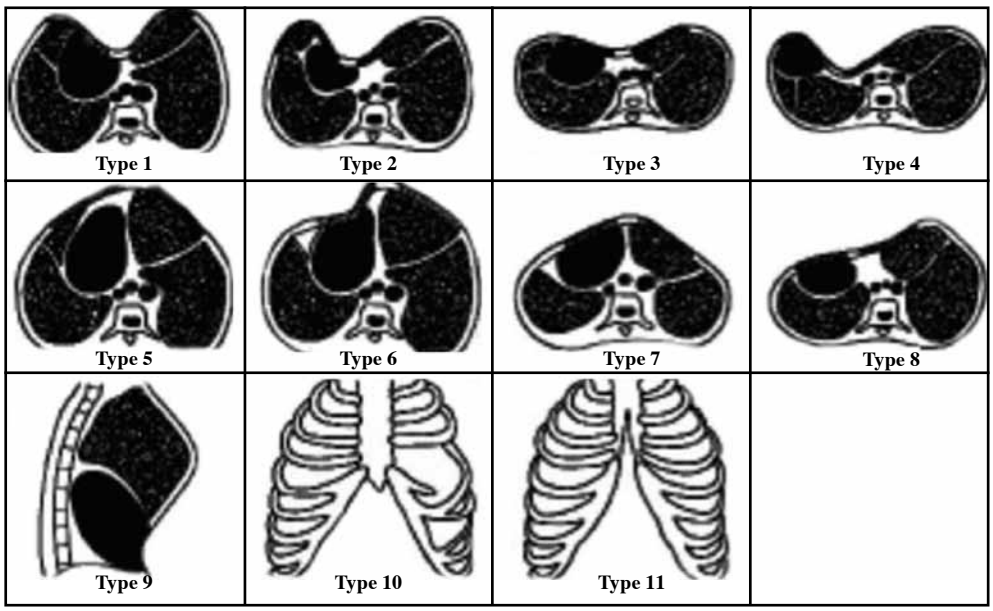

Figure 2. Classification of Pectus Deformities.

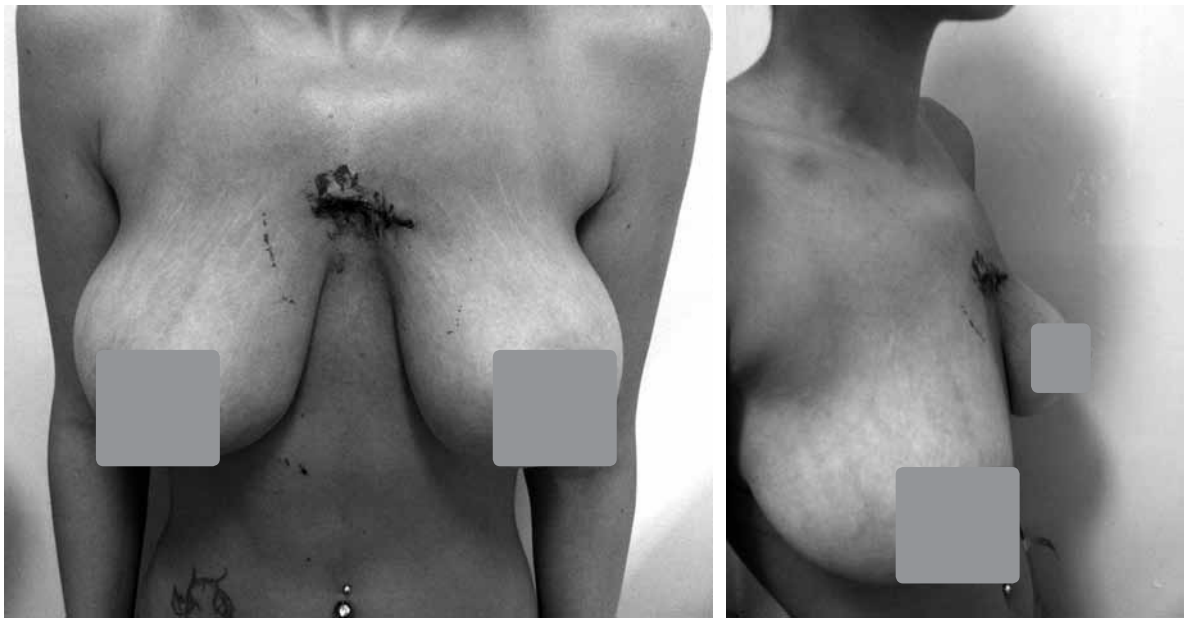

Figure 3. Postoperative mixed-type pectus excavatum patient's images.

pre- and postoperative periods after obtaining their informed written consent (Figure 3). Routine follow-ups were performed for one year, and no complications or recurrences were seen in the early or late postoperative periods.

The cardiac pressure findings were evaluated postoperatively via thoracic 3D CT and electrocardiography (ECG) (Figure 4), and as in the preoperative period, no pathology was found. However, the cardiac displacement findings were no longer present in the 3D CT images. The FEV_1 values were 2.6±0.6 liters (minimum: 2.0; maximum: 3.7), and the FVC values were 3.3±0.4 liters (minimum: 2.7; maximum: 4.1) when the PFT was carried out at the sixth postoperative month. The Mann-Whitney U test was used to compare the pre- and postoperative results of the PFT. The *p* value between the preoperative FEV_1 and postoperative FEV_1 was 0.753. We also used a single-step questionnaire (SSQ) at the sixth postoperative month to assess the patients' satisfaction regarding surgery,[4] and six of the patients rated the results as "extraordinary" while two others gave it a "good" rating.

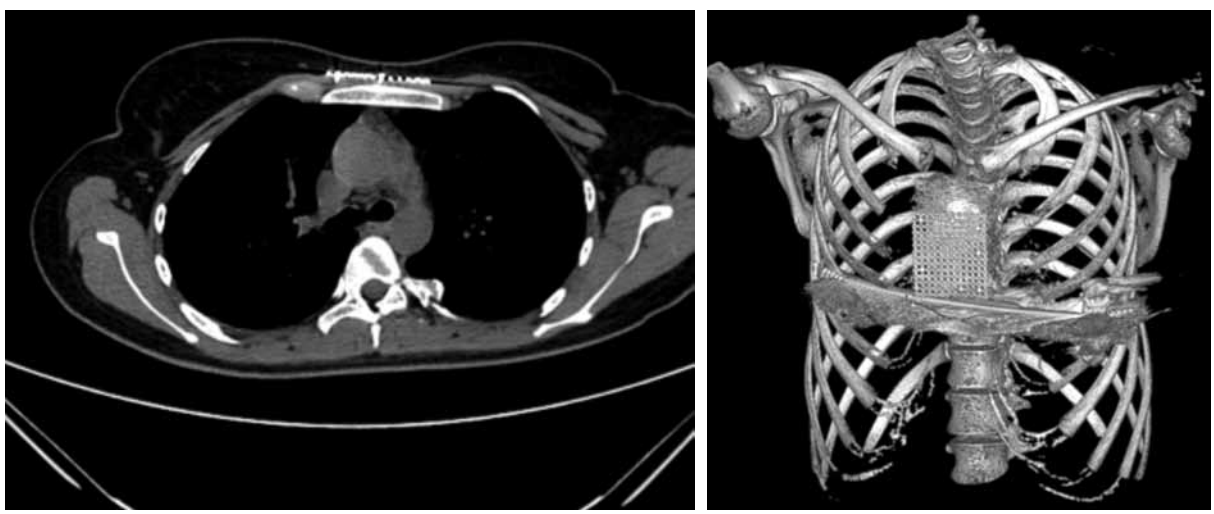

Figure 4. Postoperative three-dimensional thoracic computed tomography.

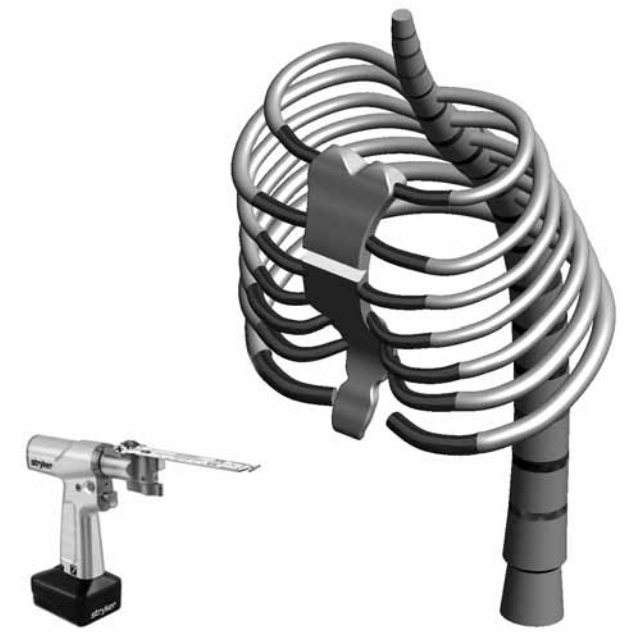

Figure 5. Wedge osteotomy performed by re-do sternotomy saw.

Surgical method

The Onen procedure began with each patient undergoing endotracheal intubation preoperatively to repair the mixed-type chest deformity, and this was followed by balanced anesthesia. The patients were kept in the supine position with their arms positioned at their right and left sides during abduction. A vertical incision of 3.5-4 cm was done so that the fibers that were adhering to the sternum of the pectoral muscle could be cleared with respect to the PC. The deformed cartilage ribs, which were causing the manubrium sterni to shift forward, were then dissected subperiostally on both sides, and the sternum was freed to the posterior from these sections. After this, an anterior wedge osteotomy was performed on the most protrusive spot with a re-do sternotomy saw (Figure 5). Following this step, the Nuss procedure was carried out for the PE deformity. The form which the chest is supposed to take was set with a copper template, and a stainless steel Biomet Microfixation Lorenz Pectus Support Bar was formed accordingly (Biomet, U.K. Ltd., Bridgend, South Wales). The incisions were made from the front axillary lines, and the skin was removed. Afterwards, a thoracoscope was introduced to the thoracic cavity. The transition from the right side to the left hemithorax was provided via dissectors using the tunnels that had previously been marked after the dissection of the tissues above the pericardium and below the sternum. The thoracoscope was then removed. Next, we attached nylon tape to the tip of the dissector and moved it first to the right hemithorax and then to the outside of the thorax. The support bar with the attached tape was subsequently inserted through the tunnel with the use of the tape to correct the chest wall concavity. The bar was then rotated, the reshaped sternum was moved forward, and a fixator was placed on the left side of the bar in order to prevent it from rotating. Because of the placement of the pectus bar, the anterior osteotomy performed on the manubrium was done in a fixed position to prevent any changes. To accomplish this, we used Wang's titanium mesh and screws, and closure was performed according to the anatomy. While the pectus bar was being attached to the fixator with a 0/5 steel wire, it was also sutured to the

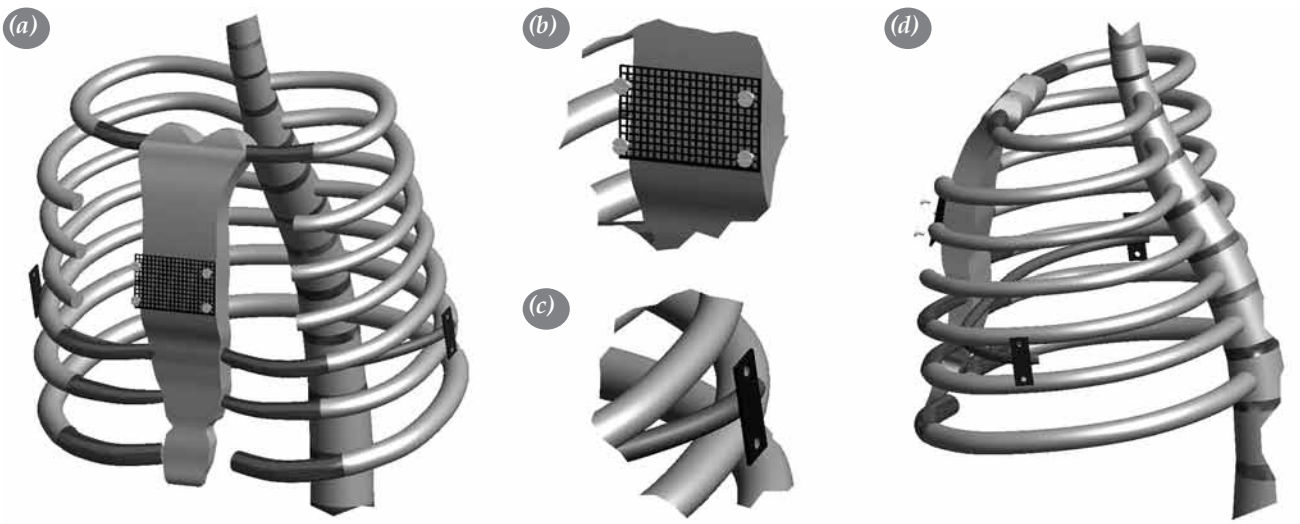

Figure 6. (a-d) Illustrations of Onen procedure.

muscles via absorbable stitches (Figure 6). The bilateral incisions were closed in accordance with the anatomy, and the chest cavity was checked via the thoracoscope. The Onen procedure was then finalized after the air had been evacuated through an aspiration catheter inserted via thoracoport hole.

DISCUSSION

Ravitch[5] defined the first accepted surgical approach for pectus deformities in 1949. His procedure involved the resection of the cartilage ribs along with the elevation or depression of the sternum when performing osteotomies on the sternum. In 1979, Robicsek added to the Ravitch procedure by applying a different principle in which the sternum is supported by putting Marlex® mesh under the sternum of PE patients,[6] and in 1998, Wang et al.[7] first used titanium mesh and screws for the same purpose. These procedures necessitate wide resections and require a blood transfusion. In addition, they do not offer sufficient recovery from the symptoms and cause pain in the postoperative period. Furthermore, there is scarring from the dermal incisions. Research has continued over the years to find less invasive approaches, and with that in mind, the minimally invasive Nuss method was developed in 1998 by Donald Nuss for those suffering from PE.[8] This surgical method, which is performed with a thoracoscope, is now widely accepted because of its low mortality and morbidity rates and since no blood transfusions are needed. In addition, the operation duration and length of hospital stay are shorter. Based on the Nuss method, Abramson[9] came up with a minimally invasive surgical approach for PC cases in 2001. Previously, that approach had usually only been carried out for isolated PE or PC deformities. Many studies have been published regarding these surgical methods, and for mixed-type pectus deformities, the Ravitch procedure is still commonly used.[10]

The Onen procedure lasted an average of 60 minutes (45-90 minutes), and the patients were discharged after an average of three days (2-5 days). No mortality or morbidity was observed in either the preoperative or postoperative periods, and unlike with the Ravitch method, there was no scar formation or need for a massive blood transfusion in the postoperative period because of overresection. The PFT values of our patients significantly improved in the postoperative follow-up period. Although three of the patients had suffered from exertional dyspnea due to the PE deformity on the preoperative clinical evaluation, none had this complaint in the postoperative period.

In addition, all of the patients stated that their exertional capacities had increased, and the cardiac pressure and cardiac displacement findings detected during the preoperative physical examination and thoracic 3D CT were no longer present. Moreover, while 75% of our patients rated their satisfaction level with the operation as “extraordinary” and 25% rated it as “good” in the early postoperative period, 100% gave a satisfaction rating of “extraordinary” in the late postoperative period.

In conclusion, by using the Onen’s surgical procedure, we achieved a higher level of patient satisfaction and lower complication rate compared with other techniques, such as the Ravitch method. Our findings showed that this new procedure is reliable and successful and that it can be used for those suffering from mixed-type pectus deformities in selected patients. However, because the number of cases that have undergone this procedure is low, further studies are needed to verify the reliability of this new procedure.

Declaration of conflicting interests

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