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References

1. Mendeloff EN. The history of pediatric heart and lung transplantation. *Pediatr Transplant* 2002;6:270–9.
2. Cypel M, Yeung JC, Liu M, Anraku M, Chen F, Karolak W, et al. Normothermic ex vivo lung perfusion in clinical lung transplantation. *N Engl J Med* 2011;364:1431–40.

Alternatives to Titanium Implants for Pectus Excavatum Repair

To the Editor:



The Annals published two articles reporting the disruption of titanium implants after chest wall resection or repair of pectus deformities [1, 2], concerning both the STRATOS system (MedXpert, Eschbach, FRG) and the MatrixRib Fixation System (Dupuy-Synthes, West Chester, Penn). Implant fracture occurred with a median follow-up time of 6.6 months to 2 years [1, 2]. The number of implants did not alter the risk of disruption. Anterior chest wall reconstruction was a risk because implants are challenged by combined tensile, bending, and rotational stress [2, 3].

These studies contain a couple of important messages. Titanium implants offer satisfactory mechanical resistance for lateral chest wall reconstruction. They are still a privileged option for anterior chest wall reconstruction, offering initial stability in combination with a soft tissue patch; we may assume that periprosthetic fibrosis occurring during the first postoperative months will lead to a stable chest wall even if the implant is disrupted.

Stabilization after correction of pectus excavatum differs from chest wall resection by the younger age and increased exercise abilities of the patients. The chest wall should be stable enough 6 months after a Ravitch repair to enable planning for early removal of titanium implants before fatigue rupture [2]. However, compliance of the relatively soft titanium to the sternal elastic recoil results in anteroposterior bending stress, which may affect the final cosmetic result. We recently started

to use a novel approach for pectus repair as described by Rudakov and colleagues [4], which represents a double innovation. First, staged subperichondral resections of all deformed cartilages are performed through two short incisions in the submammary fold. Second, the sternum is lifted up and stabilized with an original nitinol implant (KRI bar, KIMPF, Moscow, Russia). The shape of this implant mimics a seagull spreading its wings: the wing-parts lie down laterally onto the ribs, and stabilizers may be added to neutralize rotational stress; the body part presents a slight depression hosting the sternum. Nitinol offers two fundamental properties: thermomodulation and elasticity with memory of shape. The implant softens when cooled down and may be bent for easy insertion into a retrosternal tunnel created by blunt finger dissection; it pops back to its initially customized shape when heated above 27°C. Elasticity with memory of shape offers dynamic osteosynthesis with reduced pain [4].

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References

1. Sharma PK, Willems TP, Touw DJ, Woudstra W, Erasmus ME, Ebels T. Implant failure: STRATOS system for pectus repair. *Ann Thorac Surg* 2017;103:1536–43.
2. Berthet JP, Caro AG, Solovei L, et al. Titanium implant failure after chest wall osteosynthesis. *Ann Thorac Surg* 2015;99:1945–52.
3. De Groote A, Wantier M, Cheron G, Estenne M, Paiva M. Chest wall motion during tidal breathing. *J Appl Physiol* 1997;83:1531–7.
4. Rudakov SS, Kollerov MI, Korolev PA. The radical minimal access thoracoplasty by funnel chest in adults. *Khirurgiia (Mosk)* 2011;7:36–42.

Reply

To the Editor:



In their letter [1] regarding our article [2], Drs Massard and Falcoz propose that an alternative to titanium implants for pectus repair is necessary and introduce a Russian technique [3] using an innovative shape memory nitinol alloy. A similar optimistic change of material from stainless steel to titanium was implemented with the STRATOS system, which resulted in these recent fatigue failures. In our opinion, the reason for these fatigue failures is not per se because titanium is a soft material as the material choice always goes hand in hand with design; in other words, the internal stresses should remain below a threshold value. In our recent article [2], we have tried to estimate these internal stresses to approximately 300 MPa, and by a slight change in design, the internal stresses can be reduced to a level where titanium can withstand many folds higher breathing cycles than 8.5 million [2]. The other design change could be to remove regions with reduced cross-section because 35% of the failures took place at these points. The problem of slipping at the crimp connector can be solved by making the teeth more prominent than they are presently. Any design changes should be accompanied by well-documented and extensive testing by the manufacturers themselves or in collaboration with an academic research group using models that can

simulate the complex stresses encountered in vivo. Use of a completely new system [3] is not a guarantee that clinical failures can be completely avoided, certainly not in the absence of well-documented test results.

Interestingly, the researchers from the clinic where the STRATOS system was developed did not contest our findings as published. In addition to the metallurgical arguments, this particular system was never designed to be removed, a feature that surgically poses quite a challenge when attempting to do so. Therefore, the entire design must be deemed to be flawed for pectus repair. The other important question is why we should not revert to Ulrich's excellent and cheap Rehbein stainless steel material that was perfectly suited for repair of pectus deformities unsuitable for the now standard Nuss bar procedure [4]. The advantage of nitinol for this purpose is not immediately clear, and we should adhere to rigorous preclinical and clinical testing before introducing yet another expensive and unproven design.

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References

1. Massard G, Falcoz PE. Alternatives to titanium implants for pectus excavatum repair (letter). *Ann Thorac Surg* 2017;104:2121.
2. Sharma PK, Willems TP, Touw DJ, Woudstra W, Erasmus ME, Ebels T. Implant failure: STRATOS system for pectus repair. *Ann Thorac Surg* 2017;103:1536-43.
3. Rudakov SS, Kollerov MI, Korolev PA. [The radical minimal access thoracoplasty by funnel chest in adults]. *Khirurgiia (Sofia)* 2011:36-42.
4. Park HJ, Lee SY, Lee CS, Youm W, Lee KR. The Nuss procedure for pectus excavatum: evolution of techniques and early results on 322 patients. *Ann Thorac Surg* 2004;77:289-95.

Risk Factors in the Management of Repeated Lung Resection for Colon Adenocarcinoma Metastasectomy



To the Editor:

We read the article by Hishida and colleagues [1] about the outcomes in patients who underwent repeated lung resection (RLR) for colon adenocarcinoma metastasectomy. It is known that in selected patients, surgical repair is the best treatment for initial single or multiple metastases when primary cancer has been controlled. This recommendation is solid even though pulmonary metastasis originates by hematogenous spread and is a systemic disease. However, when metastasis recurs, surgical repair cannot be considered as adequate as systemic chemotherapy.

We are surprised that the results in that article also showed that RLR for limited recurrence in the lung after resection of pulmonary metastases from colorectal cancer provided favorable outcomes as for the initial metastasis.

The authors' study is interesting and well structured; moreover, the conclusions are useful in clinical practice, but some considerations are needed.

First, in their population the authors found only two prognostic factors associated with worse outcomes: (1) liver metastasis at the initial metastasectomy and (2) primary tumor location in the rectum. However, a recent article by Hamaji and coworkers [2] showed that the only prognostic factor for initial colon pulmonary metastasis surgically treated was nodal involvement. They enrolled a wide population of 518 patients and 720 metastasectomy from a single center.

By contrast, Hishida and coworkers [1] did not even include nodal state in their statistical analysis. Was this due to a lack of data, or did they not consider this factor important in the management of metastasis recurrence? In our opinion, nodal involvement, which is a signal of lymphatic tumor spread, significantly influences the outcomes both for initial metastasis [3] and recurrent metastasis. Second, unfortunately they did not register the number and size of metastases before repeated lung resection. In our opinion, these data are very important because relapses are often multiple and bilateral. Therefore, it should be useful to understand whether patients with more than one recurrence should be surgically treated as well.

We congratulate the authors, but more information about the role of lymphadenectomy and surgical management in multiple recurrences could have been useful.

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References

1. Hishida T, Tsuboi M, Okumura T, et al. Does repeated lung resection provide long-term survival for recurrent pulmonary metastases of colorectal cancer? Results of a retrospective