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Minimally Invasive Mitral Valve Repair with Intercostal Cryoablation: A Case Report

Luisa Humpfle[1] Andreas Böning[2] Bernd Niemann[1]

[1] Department of Adult and Pediatric Cardiac and Vascular Surgery, University Hospital Giessen and Marburg Campus Giessen, Giessen, Hessen, Germany
[2] Department of Cardiovascular Surgery, University Hospital Giessen, Giessen, Germany

Address for correspondence Luisa Humpfle, MD, Department of Adult and Pediatric Cardiac and Vascular Surgery, University Hospital Giessen and Marburg Campus Giessen, Rudolf-Buchheim-Straße 7, Giessen, Hessen 35392, Germany (e-mail: luisa.humpfle@uk-gm.de).

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Abstract

Background Minimally invasive lateral thoracotomies may cause severe postoperative pain and discomfort. We describe an intraoperative intercostal cryo-neuronal pain block as one possibility for postoperative pain relief.

Case description A 63-year-old male patient underwent minimally invasive mitral valve repair. To reduce postoperative pain, an intercostal cryo-neuronal ablation was performed. The consecutive course was pain-free.

Conclusion Intraoperative cryo-neuronal nerve block may be a standard procedure during minimally invasive cardiac surgery.

Keywords
- minimally invasive surgery (includes port access
- minithoracotomy)
- nerves
- cranial or peripheral
- mitral valve surgery

Introduction

A lateral thoracotomy, performed during minimally invasive (MIC) mitral valve (MV) surgery, can be associated with severe postoperative pain (POP). This may lead to respiratory insufficiency, pulmonary infections as well as a delayed postoperative mobilization. Opioid application is often associated with side effects like sedation, respiratory depression, or addiction. Intercostal cryoablation (ICA) may help to reduce these complications. ICA is already known to be effective for POP management after full thoracotomy.[1] ICA patients maintain postoperative forced expiratory volume in 1 second in comparison to standard of care pain medication.[2] Nevertheless, ICA has not yet been established as a standard procedure for POP after MIC MV surgery.

Case Description

A 63-year-old male patient presented with shortness of breath and physical degradation II–III according to the New York Heart Association (NYHA). Echocardiography revealed MV regurgitation with annulus dilatated to 38×39 mm and a prolapse of the posterior mitral leaflet P2 due to rupture of chordae tendineae. This resulted in a grade 4 MV regurgitation with a preserved ejection fraction. Electrocardiography showed a first-degree atrioventricular block. He had a medical history of a chronic B-cell lymphocytic leukemia treated with a tyrosine kinase inhibitor, but no further cardiac comorbidities. A coronary heart disease was ruled out.

We performed an MIC MV via lateral minithoracotomy in the fifth intercostal space without the use of intercostal spreaders. Uneventful cannulation was performed via right femoral vena and arteria. P2 was supported using four 16-mm neochordae and the annulus was reconstructed with a 28-mm Memo 4 D ring. The postoperative result showed no residual MV regurgitation with a mean pressure gradient of 2 mmHg. The right lateral pleura was drained with a chest tube, which could be removed on the second postoperative day (POD) with minimal serous flow and an expanded lung

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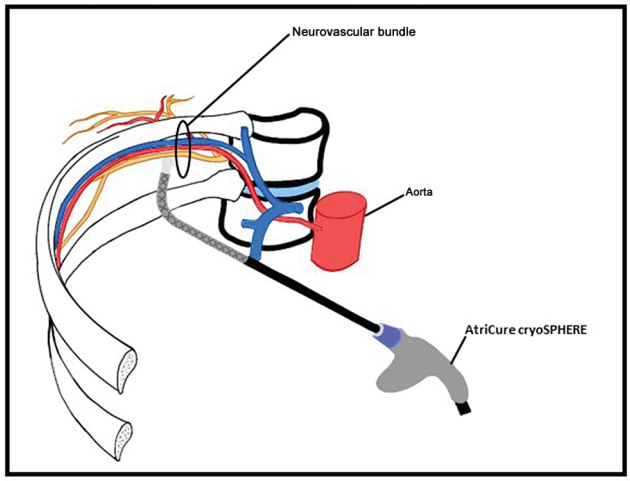

Fig. 1 Schematic illustration of the placement of the bended cryo-probe onto the neurovascular bundle.

without signs of edema. Perioperatively left ventricular function always maintained well; a minimal administration of vasopressors perioperatively could be terminated a few hours postoperatively.

Before closure of the thoracotomy, cryoablation of the intercostal nerves was performed. Therefore, two intercostal spaces above and below the intercostal space used for thoracotomy are treated with a cryo-neuronal pain block. A cryoSPHERE (AtriCure, Inc) cryoablation probe is used. Each ablation was performed at the lower edge of the rib directly on the visible intercostal nerve. The malleable shaft is bended to achieve the best possible placement without damaging or touching other structures (►**Fig. 1**).

Under visualization the probe is positioned in the intercostal muscle compressing the neurovascular bundle 2 cm from the dorsal root ganglia (►**Fig. 2**). One cycle of cryoablation at about −65° Celsius is performed for 120 seconds. The probe is removed after defrosting, avoiding mechanical damage to the intercostal nerve and vessels. The cryo-neuronal pain block was completed by an intercostal pain block using ropivacaine.

The total operation time was 3 hours and 43 minutes of which approximately 15 minutes were used for cryoablation.

The patient was transferred to the intensive care unit (ICU) and extubated on the same day 3.5 hours postoperatively without neurological deficits. Nonopioid medication with metamizole and oral medications with 25 mg pregabalin 1-0-1 and 10 mg oxycodone with naloxone 1-0-1 for immediate POP were given once. The patient was mobilized shortly after extubation and performed painless physical and respiratory therapy. Divided into three doses 9 mg piritramide (6 mg morphine milligram equivalents) was given the first night after surgery. POP and discomfort showed level 2 on a visual analogue scale (0 = no pain to 10 = maximal possible pain). The patient was transferred to the standard ward on the morning of POD 1. The cryoanesthetized dermatome was checked daily (►**Fig. 3**). The patient reported numbness without any discomfort and continued freedom from pain. There was no further need for analgesics up to discharge on POD 7 to a rehabilitation center. Clinical follow-up at our department on POD 90 showed normal sensation without paresthesia of the previously cryoanesthetized dermatome, and inconspicuous and identical perception of touch and pain stimuli. The patient reported no need for painkillers in the meantime.

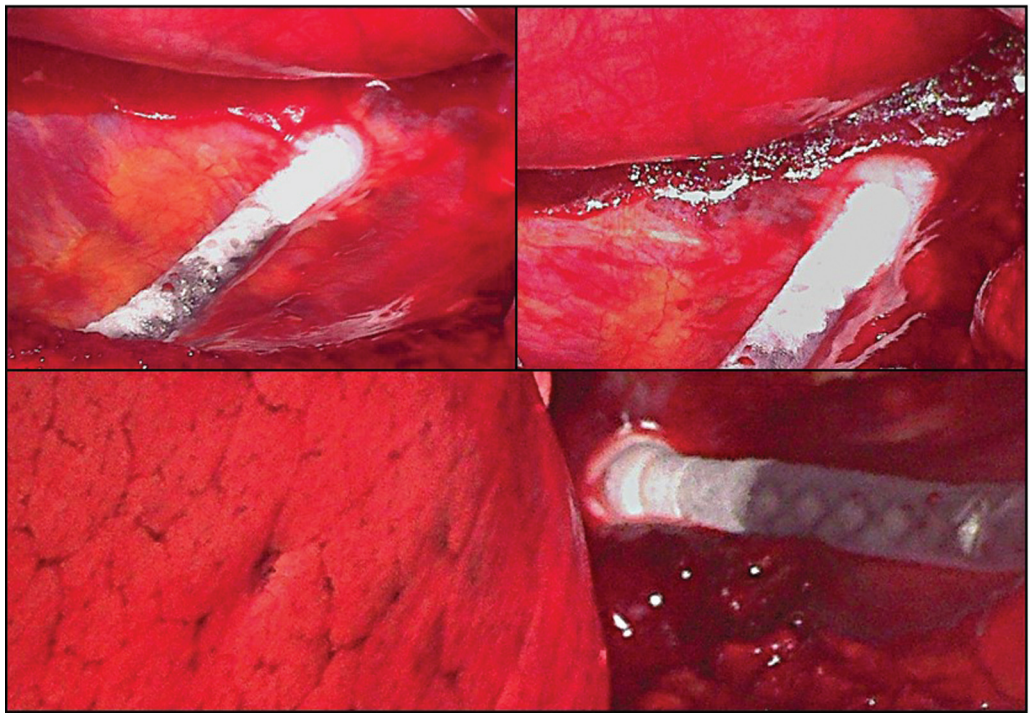

Fig. 2 Positioning of the cryo-probe in the intercostal space of the operative access at the lower edge of the rib.

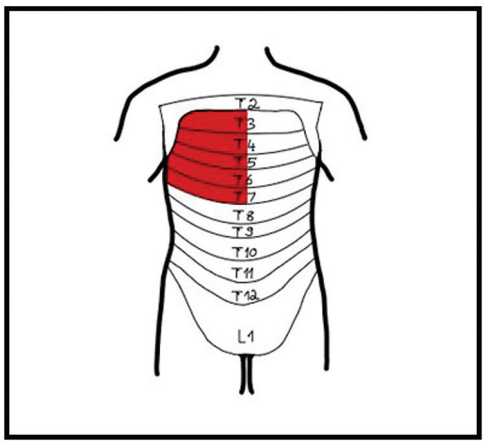

Fig. 3 Schematic drawing of the cryoanesthetized dermatomes T3–T7.

Discussion

We report this first intercostal cryoablation during MIC MV repair as a possible component of ERAS programs. Previously published studies and reports using cryoablation presented patients undergoing surgery in anterior mini-thoracotomy, bilateral anterolateral sternal-sparing thoracotomy, bilateral thoracosternotomy, or full sternotomy.[2–4]

As cardiac surgery is often related to the use of a cardiopulmonary bypass with anticoagulation, epidural analgesia and other local anesthetic procedures can be associated with a higher risk for hematoma and bleeding complications. Furthermore, these techniques may reduce acute POP, but cannot help with long-term pain relieve. Poorly treated POP can turn into persistent POP, which negatively affects the patient's quality of life.[5] Consequently, patients undergoing cardiac surgery are treated with opioid analgesics. These are related to sedation, respiratory insufficiency, or addiction.[2] Previous studies have already shown that ICA can reduce the usage of opioid analgesics in the direct postoperative course,[1–4,6] and since the axons in the intercostal nerves regenerate at a rate of 1 to 2 mm per day the pain relieve lasts for several weeks.

In terms of technical feasibility, ICA is a fairly simple procedure. The risk of potential mechanical complications is low since the ablation is done under visualization and a defrosting mode is used afterwards. There is no additional risk of pneumothorax related to the procedure itself. Intraoperatively, chest tubes are used according to the routine of the main operative procedure. Additional procedural time is needed to perform ICA during operation; however, without prolongation of cardiopulmonary bypass time it may be performed parallel to accompanying procedures.[3] At best, the nerve-ablation site is as dry as possible. Therefore, it seems sensible to carry out ICA at the beginning of the operation before further cardiac procedures. In addition, possible neuropathic pain in the immediate vicinity of the ablation is minor while main procedures are performed resulting in direct postoperative freedom from pain.

On the one hand, the rapid postoperative regeneration process in the pain-free patient and the quick, uncomplicated transfer to standard ward and rehabilitation can lead to an increase in patient satisfaction. On the other hand, this contributes to optimized utilization of surgical and ICU resources in the sense of ERAS concepts and avoidance of long waiting lists. The costs invested in cryoablation must therefore be offset against the gain in treatment capacity. Future analyses for this are desirable.

In conclusion, we present ICA during MIC MV repair as a possible standard procedure for POP relieve. Patients require lower doses of opioid analgesics, fully recover, and show an unaltered quality of life after rehabilitation without POP or dysesthesia.

Conflict of Interest
None declared.

Acknowledgments
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