On-table extubation is associated with reduced intensive care unit stay and hospitalization after trans-axillary minimally invasive mitral valve surgery

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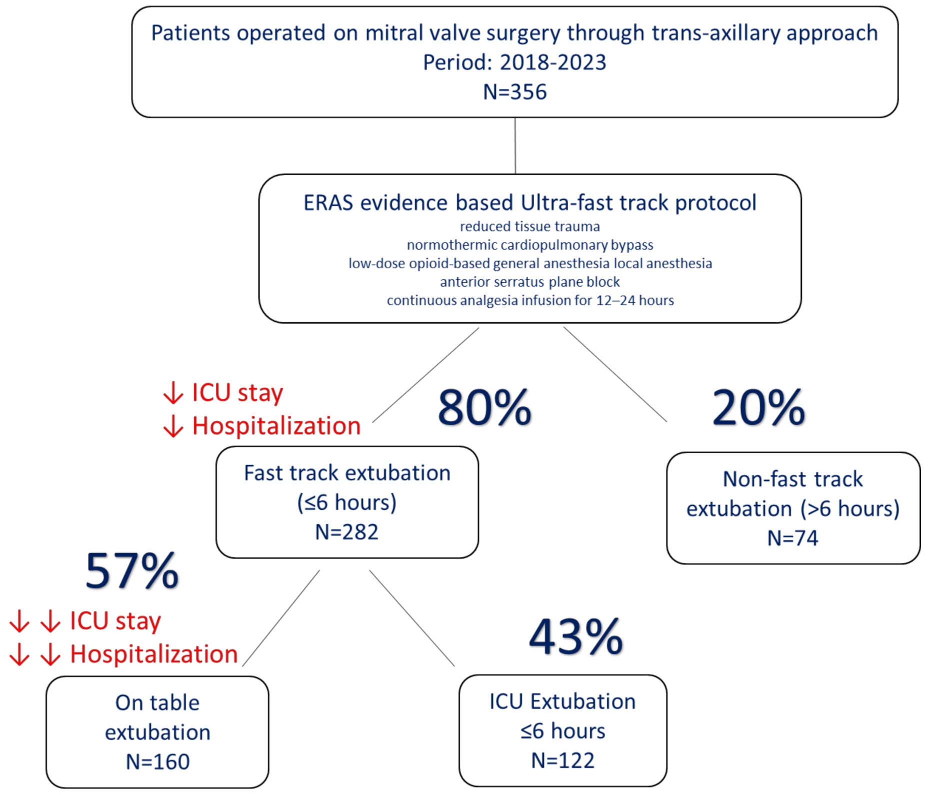
Central image

On table extubation reduces ICU stay and hospitalization after trans-axillary minimally invasive mitral valve surgery

Summary

Fast track extubation was achievable in most of the patients undergoing trans-axillary minimally invasive mitral valve surgery and was associated with higher rates of day 1 Intensive Care Unit discharge and discharge home. On table extubation was associated with further reduced Intensive Care Unit stay and hospitalization.



Title: On table extubation is associated with reduced Intensive Care Unit stay and hospitalization after trans-axillary minimally invasive mitral valve surgery

Running title: Early extubation in trans-axillary mitral valve surgery

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Visual abstract

Key question: Does on table extubation offer any advantage in trans-axillary mitral valve surgery?

Key findings: On table extubation within an ultra-fast track protocol is associated with reduced postoperative ICU and hospitalization.

Take-home message: Protocols including early extubation in trans-axillary mitral valve surgery are safe and contribute to a shorter patients' hospitalization.

Abstract

Objectives. Few data are available regarding early extubation after mitral valve surgery. We sought to assess the impact of an Enhanced Recovery After Surgery based protocol – ultra-fast track protocol – in patients undergoing minimally invasive trans-axillary mitral valve surgery.

Methods. Data of patients who underwent trans-axillary mitral valve surgery associated with ultra-fast track protocol between 2018 and 2023 were reviewed. We compared preoperative, intraoperative and postoperative data of patients who had fast track extubation (≤6 hours since the end of the procedure) and non-fast track extubation (>6 hours) and, within the fast track group, patients who underwent on table extubation and patients who were extubated in Intensive Care Unit within 6 hours. Multivariable logistic regression was used to study the association of extubation timing and Intensive Care Unit stay, postoperative stay and discharge home.

Results. Three-hundred fifty-six patients were included in the study. Two-hundred eighty-two patients underwent fast track extubation (79%) and 160 were extubated on table (45%). We found no difference in terms of mortality and occurrence of major complications (overall mortality and cerebral stroke 0.3%) according to the extubation timing. Fast track extubation was associated with shorter Intensive Care Unit stay, discharge home and discharge home within postoperative day 7 when compared to non-fast track extubation. Within the fast track group, on table extubation was associated with Intensive Care Unit stay≤1 day and discharge home within postoperative day 7.

Conclusions. Fast track extubation was achievable in most of the patients undergoing trans-axillary minimally invasive mitral valve surgery and was associated with higher rates of day 1 Intensive Care Unit discharge and discharge home. On table extubation was associated with further reduced Intensive Care Unit stay and hospitalization.

Abstract word count: 274

Keywords: ERAS, mitral valve, mitral valve repair, mitral valve replacement, minimally invasive surgery

Introduction

Early extubation after cardiac surgery was popularized in the late 1990s (1,2) and has subsequently been shown to be safe (3) and associated with reduced postoperative ICU and hospital stay particularly in the context of CABG and minimally invasive heart valve surgery (4-8). More recently Enhanced Recovery after Surgery (ERAS) protocols have been applied to cardiac surgery to improve patients' experience allowing shorter postoperative stays, reduced rate of transfusion and enhanced pain management (9). A growing number of observational and RCTs studies reported satisfactory early results with improved outcomes, reduced cost and increased satisfaction in patients operated on following institutional ERAS protocols (10-13). However, they mainly included small size populations with mixed cardiac surgery procedures and a limited number of mitral valve procedures.

In the last 5 years, we have developed and favoured the trans-axillary (TAxA) approach for our minimally invasive mitral valve surgery program. We have recently reported the results of the experience shared with the Unit of Cardiac Surgery of Dresden and found that TAxA surgery was performed with contained operative times and was associated, when compared with full sternotomy approach, with shorter mechanical ventilation length, postoperative stays, and discharge home without any further period of cardiopulmonary rehabilitation (14). Since 2016, we have also established an ERAS ultra-fast track protocol that has shown to be safe and associated with reduced rates of respiratory insufficiency and delirium, with shorter lengths of stay and with lower rates of early mortality and postoperative complications (15). The reduction of tissue and biological trauma represents one of the cornerstones of this protocol alongside normothermic CPB, low-dose opioid-based anaesthesia, aggressive pain management, early extubation and mobilisation.

The aim of this study was to assess the impact of ultra-fast track protocol in patients undergoing trans-axillary mitral valve surgery and to ascertain whether on table extubation is associated with any further advantage in the postoperative course.

Materials and methods

Population

The population of this study included consecutive patients who underwent first-time trans-axillary mitral valve surgery associated with an ultra-fast track protocol at our academic centre during the period January 2018 – April 2023.

Ethical statement, study design, data collection

This study is a single centre retrospective outcome evaluation from institutional records with prospective data entry. Patients' data were retrieved from the internal database of Cardiac Surgery Unit at Lancisi Cardiovascular Centre in Ancona (Italy) (approval CERM 2019 361). Several preoperative, intraoperative and postoperative data were collected.

Definitions

The definition of preoperative characteristics aligns with the notes about EuroSCORE (16). Early mortality and complications refer to events that occurred in the first 30 days since the operation. Postoperative outcomes were recorded according to the VARC-2 criteria (17).

The timing of extubation was used to characterise two groups of patients:

- ***Fast track group***: extubation within 6 hours since the end of the operation (18). This group was further characterised by considering patients who had on table extubation (*On table extubation subgroup*) after the end of surgical procedure and patients extubated in ICU within 6 hours (*Extubation≤6 hours in ICU*).
- ***Non-fast track group***: extubation after 6 hours since the end of the operation.

Aims and Endpoints

Aim of this study was to ascertain whether early extubation and on table extubation in patients undergoing minimally invasive mitral valve surgery are feasible, safe and potentially associated with any relevant clinical advantage. We assessed the following endpoints:

- Length of ICU (postoperative day 1 discharge from ICU) and global postoperative hospital stay (postoperative day 7 discharge from hospital), destination at the discharge (home vs medical or rehabilitation centre) according to Fast track and Non-fast track extubation, On table extubation and Extubation≤6 hours in ICU;
- 30-day outcomes (mortality, postoperative complications) according to Fast track and Non-fast track extubation, On table extubation and Extubation≤6 hours in ICU.

Ultra-fast track protocol

The ultra-fast track protocol for heart valve surgery has been used since 2016 in our institution (15,19). This was generated based on enhanced recovery after surgery evidence (18,20) and developed within a multidisciplinary team including surgeons, anesthesiologists, perfusionists, physiotherapists, nurses, and families. The key features of the protocol include:

- the reduction of tissue trauma through reduced chest incision as we favor trans-axillary approach with no ribs spreader for mitral valve surgery;
- normothermic cardiopulmonary bypass management;
- low-dose opioid-based general anesthesia with short-acting volatile agent (sevoflurane) to maintain anaesthesia;
- pain management through pre-operative single-shot anterior serratus plain block, local infiltration of sutures and drain sites, post-operative continuous serratus plain block for 24-48 hours and continuous analgesia infusion for 12-24 hours (tramadol 4-8 mcg/kg/min).

This setup was invariably used in all the patients undergoing minimally invasive mitral valve surgery aiming for:

- on table extubation at the end of the surgical procedure;
- respiratory therapy starting at 3–6 hours after extubation and mobilization at 6–12 hours including bed exercises, bed and chair sitting, standing position, assisted ambulation;
- oral feeding at 6–12 hours after surgery;
- patient-family contact (3 hours after extubation);
- drain removal in postoperative day 1;
- day 0 or 1 discharge from ICU.

The following criteria were used for extubation: patient alert, awake and able to follow commands; hemodynamic stability without inotropic support; no bleeding (as evaluated by the surgeon during and soon after the closure the mini-thoracotomy access), hemoglobin > 10 g/L; body temperature > 36°C; spontaneous breathing with respiratory rate < 30/min; appropriate acid-base status; PaCO2 < 50 mmHg, PaO2 > 60 mmHg (with a maximal FiO_2=50%), SpO_2 > 95%, tidal volume 5-10 ml/kg.

Supplemental table 1 summarizes the ultra-fast track protocol.

Surgical techniques and cardiopulmonary bypass

All patients received general anaesthesia and TOE was performed before and during the operation for monitoring and evaluation of the surgical result. The trans-axillary access was performed as described previously (14). Shortly, with the patient on supine position, a 4 to 5 cm skin incision was made in the right anterior axillary line at the level of the 4th intercostal space. Cardiopulmonary bypass was established through femoral vessels cannulation using Seldinger technique and TOE guidance after surgical cut-down. The right jugular vein was cannulated before surgical draping. The cardiopulmonary bypass was conducted maintaining normothermia after cannulation of the common femoral artery (3/8” line and a 18-22 French cannula, to allow a cardiac index of 2.4l/min * body surface area), the femoral vein (1/2” venous line with a 15-27 French multi-stage cannula) and the right internal jugular vein (3/8” line and a 16-18 F cannula). Centrifugal pumps and a membrane oxygenator with integrated arterial filter were used in all the cases. Vacuum-assisted venous drainage was invariably adopted with a mean pressure of [-20, -25] mmHg and never exceeding the value of -40 mmHg. The aorta was occluded using a flexible clamp introduced through the mini-thoracotomy access and crystalloid cardioplegia was then delivered through a needle in the ascending aorta. Histidine-Tryptophan-Ketoglutarate cardioplegia was used until December 2021, del Nido cardioplegia was given in all the cases thereafter. The left atrium was opened using a left atrial atriotomy in the inter-atrial groove. The mitral valve apparatus was exposed on direct vision with the aid of an atrial retractor, no video assistance tool was used. Video supports are available at https://www.minicardiacsurgery-univpm-research.com/video-gallery/. Several repair techniques, such as leaflet resection, implantation of artificial chords and annuloplasty rings were used. Mitral valve replacement was performed using the common stented biologic or mechanical substitutes anchored with 2/0 non-adsorbable interrupted sutures with pledgets.

Statistical analysis

Continuous variables were expressed as mean (SD) or median with interquartile range (IQR). Categorical variables were expressed as frequencies and percentages. Comparisons of preoperative, intraoperative and postoperative variables were performed between the fast track and non-fast track extubation cohorts using the appropriate test (Student’s t-test or Mann-Whitney U test, χ^2 or Fisher’s exact test). A logistic regression was performed to study the association between preoperative characteristics (*age, gender, chronic kidney disease (eGFR<50 mL/min/1.73m^2), NYHA III/IV, LVEF (%), systolic pulmonary artery pressure (>30 mmHg), isolated mitral surgery, degenerative mitral valve disease, cardiopulmonary bypass time*, and the likelihood of undergoing fast track extubation. A logistic regression analysis was used to study the association between each of the following outcomes, *ICU length of stay (cut off 1 day), overall postoperative hospital stay (cut off 7 days), discharge home, discharge home within postoperative day 7*, and fast track extubation, by including in the multivariable model the following variables that were judged as potential confounders, *age (years), gender, chronic kidney disease (eGFR<50 mL/min/1.73*m^2*), NYHA III/IV, LVEF (%), systolic pulmonary artery pressure (>30 mmHg), isolated mitral surgery, degenerative mitral valve disease, cardiopulmonary bypass time*. A specular analysis was conducted in patients in the fast track group by considering the two subgroups On table extubation and Extubation≤6 hours in ICU.

A p-value of ≤0.05 was considered statistically significant. The analysis was generated using Statistical Analysis Software (SAS), Version 3.8, SAS University Edition (SAS Institute Inc., Cary, NC). Figure 1 outlines the design of the study.

Results

During the study period 356 patients were scheduled for minimally invasive mitral valve surgery following the ultra-fast track protocol and represented the subjects of this study. The preoperative characteristics of the overall population who underwent trans-axillary mitral valve surgery are summarised in Supplemental Table 2. Mitral valve repair was performed in 94% of the patients with degenerative disease. Nineteen patients with degenerative disease had valve replacement – octogenarians with heavy annular calcification (n=8 patients, mean age 83 years old), because of leaflets/chordal calcification (n=3) or diffuse bileaflets degenerative lesions (n=4), unsatisfactory repair result at intraoperative evaluation (n=4). Mean cross-clamp time was 65±23 minutes and mean cardiopulmonary bypass time was 103±33 minutes (Supplemental Table 3). 30-day mortality was 0.3% (1 patient who died after multiple complications associated with iatrogenic aortic dissection), postoperative cerebral stroke rate was 0.3%. Supplemental Table 4 provides details regarding postoperative outcomes.

Median mechanical ventilation time was 3 [0-6] hours. Four patients experienced major intraoperative complications and they could not be considered for an early extubation (iatrogenic aortic dissection, intraoperative acute myocardial infarction, injury of thyroid cartilage, compromised gas exchange and ventilation). In total 74 patients (21%) were ultimately extubated after 6 hours since the end of the surgical procedure (Non-fast track group). Two hundred eighty two patients (79%) were extubated within 6 hours since the end of the operation (Fast track group). One hundred sixty patients (45%) were extubated in theatre immediately after the operation and before the transfer to ICU – On table extubation subgroup – and underwent through the ultra-fast track pathway. Figure 2 provides a graphical illustration of the adoption of fast track and on table extubation throughout the study period. Mean postoperative global hospital stay was 7 days with 47% of the patients discharged home without the need for any further period of cardiopulmonary rehabilitation or transfer to medical facilities. Figure 3 provides a graphical illustration of the percentage of patients discharged home throughout the study period.

Fast track vs non-fast track

There was no difference in preoperative characteristics between fast track (n=282) and non-fast track (n=74) patients (Table 1, Supplemental Figure 1 panel A). None of the preoperative variables was associated with the likelihood of undergoing fast track extubation. Among operative factors, a shorter CPB time was independently associated with fast track extubation (Supplemental table 5). No difference was found between the two groups in terms of 30-day mortality, postoperative cerebral stroke, reintubation for respiratory failure, occurrence of postoperative atrial fibrillation.

ICU ($p<0.001$) and hospital stays ($p=0.005$) were shorter in fast track group, furthermore these patients had a higher rate of discharge home (52% vs 26% in non-fast track; $p<0.001$) (Table 2). Multivariable analysis results are summarised in Table 5 and showed that fast track extubation was associated with ICU stay≤1 day, discharge home and discharge home within postoperative day 7. This analysis was carried out excluding the 4 patients who had major intraoperative complications since they were not considered for an early extubation and for whom a longer period of mechanical ventilation and ICU stay was expected.

We carried out a further analysis comparing fast track patients with non-fast track patients who had a fully straightforward early postoperative course (n=52). The twenty-two patients who were excluded from this analysis comprised the 4 patients with intraoperative complications and further 18 patients who, in the early postoperative hours, experienced events that might have impacted the length of intubation and their stay in the Intensive Care Unit [agitation (n=6), seizure (n=1), signs of myocardial ischaemia (n=3), bleeding (n=6), cervicolateral haematoma (n=1), accidental removal of chest drainage (n=1)]. We found that fast track extubation was associated with ICU stay≤1 day (OR 3.54, 95% CI 1.67-7.50, p=0.001).

Patients who underwent fast track extubation had a lower rate of reopening for bleeding (p<0.001). This finding was confirmed by multivariable analysis, including age, gender, etiology, chronic kidney disease, NYHA class, isolated mitral surgery, LVEF, CPB time (OR 0.168, 95% CI 0.047-0.602; p=0.006). Similarly, patients who had fast track extubation had a lower rate of transfusion (p=0.002) as confirmed after the exclusion of patients who experienced early reoperation for bleeding (OR 0.473, 95% CI 0.232-0.967; p=0.040).

On table extubation vs Extubation≤6 hours in ICU

One hundred sixty patients were extubated on table (*On table extubation* subgroup). Compared with patients extubated in ICU within 6 hours (n=122, *Extubation≤6 hours in ICU* subgroup), these patients were younger and had a higher mean LVEF (Table 3, Supplemental Figure 1 panel B). Younger age (p=0.047) was independently associated with the likelihood of undergoing on table extubation (Supplemental Table 6). There was no difference between these two subgroups in terms of 30-day mortality and postoperative complications. The median mechanical ventilation time in patients extubated after the transfer to ICU was 4 [3-5] hours. Patients extubated in theatre experienced a shorter stay in ICU (p=0.007) and were more frequently discharged home with no need of any further period of rehabilitation (p=0.002). Multivariable analysis results are summarised in Table 5 and showed that extubation on table was associated with ICU length of stay≤1 day and higher rate of discharge home and discharge home within postoperative day 7.

Comment

Minimal access surgery is an established, yet diverse, approach for mitral valve surgery which provides excellent results and brings lower postoperative morbidity (21-24). Regardless of the choice of surgical access and its inherent techniques – anterior/lateral/trans-axillary mini-thoracotomy, endoscopic, thoracoscopic, robotic – a minimally invasive approach should go far beyond the goal of a small incision.

The concept of pursuing an early extubation is not new in cardiac surgery as several studies have already underscored the benefits associated with a fast track extubation especially in OPCABG and CABG operations, mini heart valve surgery and transapical TAVI (4-8,25,26). However, only in recent years, a series of evidence-based perioperative care pathways have been embedded into cardiac surgery practice with the aim of reducing the physiological and psychological trauma and achieving a quick recovery (10-13). These experiences yet included mixed types of surgical operations with few mitral valve cases.

Our study was entirely focused on patients operated on for mitral valve disease. The first noteworthy finding was that following trans-axillary surgery with ultra-fast track anaesthetic, perfusion and pain management, almost 80% of our mitral patients were extubated within 6 hours after the end of surgical procedures and on table extubation soon after the completion of surgery was achieved in almost 45% of the cases. Our data showed that early extubation (≤6 hours) was safe with <1% of the patients requiring reintubation for respiratory failure. We found no difference in the usual hard endpoints including 30-day mortality and perioperative cerebral stroke between patients who had fast track and non-fast track extubation. Nevertheless, the former experienced shorter ICU stay and hospitalization as shown by the multivariable analysis including several potential confounders. These data were also confirmed by a sub-analysis comparing non-fast track patients who had a straightforward early postoperative course (median mechanical ventilation time 10 hours) with fast track patients (median mechanical ventilation time 4 hours). A delayed extubation was again associated with a lower probability of day 1 ICU discharge. These data are difficult to compare due to paucity of similar experiences in mitral surgery. A recent analysis from the German Heart Center team in Berlin (8) based on mitral patients treated with a video-assisted thoracoscopic approach for degenerative disease reported a successful fast track course (<10 hours extubation, <1 day ICU stay, no ICU readmission) in more than half of the cases with a mean postoperative hospital stay of 6 days and no mortality.

In our experience, none of the preoperative factors was associated with the likelihood of undergoing fast track extubation. Conversely, as already highlighted in literature (8,27), longer CPB time turned to be associated with non-fast track extubation. This finding further underlines the importance of aiming for a limited biological trauma together with a reduced incisional trauma. Our direct vision minimally invasive approach was characterised by operative times (mean CPB time 104 minutes, mean cross-clamp time 65 minutes) well below those normally described in mini-thoracotomy surgery (21,22,24), and this probably has favoured the pursuit of a fast track pathway in almost 80% of the cases.

Surgery – although transiently – can represent the most traumatic and disabling event for paucisymptomatic and relatively young patients and can severely affect the functional status of frail and comorbid patients. The spread of transcatheter therapies highlighted that patients' expectations are far beyond the mere technical result and focus on a fast recovery with rapid return to pre-operative lifestyle with less physical and emotional stress. Having achieved a high safety profile with a rate of mortality and cerebral stroke less than 0.5%, every effort should be made to reduce the impact of collateral discomfort and damages associated with the whole surgical and perioperative care in order to improve the patient's experience throughout the hospitalization process. Contemporary surgical techniques associated with ERAS evidence-based protocol can successfully meet these requests while guaranteeing satisfactory and durable results (9-13,15).

The first goal of our ultra-fast track protocol was the extubation in theatre soon after the end of the procedure. In the past, concerns were raised about the safety of on table extubation after cardiac surgery and its alleged advantage over an early ICU extubation (28). More recent experiences based on mixed cardiac surgery populations showed that on table extubation was safe (29,30), and our data confirmed these findings as we achieved extubation in theatre in about 45% of the patients – more than 50% in the last 2 years – with no increased risk of reintubation for respiratory failure. We have derived from our data a calculator of the probability of successfully undergoing on table extubation after minimally invasive mitral valve surgery. This calculator, which was based on univariable and multivariable logistic regression analyses including patients' preoperative and operative factors such as age, CPB time, PAPs, NYHA, gender, mitral regurgitation etiology, type of mitral valve procedure (repair or replacement), renal function (eGFR<50 mL/min/1.73m^2), LVEF, combined procedures, is available with all the relevant information in the Supplemental materials.

We found that patients who successfully entered the ultra-fast track pathway including on table extubation day 0 mobilization and physiotherapy, immediate contact with relatives, earlier feeding, experienced substantial advantages over ICU extubation≤6 hours in terms of higher rates of day 1 discharge from ICU, discharge home and discharge home within 7 days. Alongside the achievement of these results, we expect that this practice has the potential to improve the overall patients' and families' experience associated with the surgical care. A thorough investigation based on patient reported outcomes could further strengthen the value and the importance of providing a person-centred treatment taking into account not only the technical result but also addressing the request for a prompt functional recovery.

Indeed the patients included in our study represent a low-risk and selected population and the generalization of these results in high risk and unstable patients is not obvious. Nevertheless, as learnt from high risk and frail patients undergoing minimalistic intervention, the combination of reduced tissue trauma, short operative times, early extubation and mobilization, are expected to have a favourable impact on the postoperative course of more complex and comorbid patients who could certainly benefit from an established and shared institutional ERAS program.

Within these limitations, we found that fast track extubation was achievable in most of the patients undergoing trans-axillary minimally invasive mitral valve surgery and was associated with higher rates of day 1 ICU discharge and home discharge, reduced bleeding and transfusion rates. On table extubation was associated with further reduced ICU stay and hospitalization.

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Tables

Table 1. Preoperative and intraoperative data of patients who underwent fast track (extubation within 6 hours) and non-fast track extubation (extubation time>6 hours).

Variables	Fast track N=282	Non-fast track N=74	p	[SMD]
	Mean (SD) n (%)	Mean (SD) n (%)		
Age (years)	63 (12)	64 (11)	0.22	0.08
Gender (M/F)	176/106	40/34	0.19	0.16
BMI (kg/m^2)	24.9 (4.2)	24.7 (4.5)	0.53	0.05
COPD	7 (2)	4 (5)	0.36	0.16
CKD (eGFR<50 mL/min/1.73m^2)	37 (13)	8 (10)	0.59	0.09
NYHA class≥III	88 (31)	26 (34)	0.52	0.06
History of AF	70 (25)	21 (28)	0.53	0.07
LVEF (%)	61 (7)	60 (8)	0.33	0.14
Mitral regurgitation	269 (95)	68 (92)	0.23	0.12
Degenerative MR	250 (89)	63 (85)	0.40	0.11
PAPs≥30 mmHg	100 (35)	32 (43)	0.21	0.16
Tricuspid regurgitation ≥ moderate	68 (24)	15 (20)	0.49	0.10
EuroSCORE II (%)	1.2 (1.0)	1.2 (0.8)	0.13	0
Isolated MV surgery	239 (85)	66 (89)	0.33	0.12
Mitral valve repair for MR	250/269 (93)	57/68 (84)	0.018	0.28
Mitral repair for degenerative MR	236/250 (95)	55/63 (90)	0.006	0.32
CPB time (minutes)	100 (26)	119 (44)	<0.001	0.62
Cross-clamp time (minutes)	62 (20)	75 (30)	<0.001	0.58

AF, atrial fibrillation; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; LVEF, left ventricle ejection fraction; MR, mitral regurgitation; MV, mitral valve; PAPs, systolic pulmonary artery pressure

Table 2. Postoperative data of patients who underwent fast track (extubation within 6 hours) and non-fast track extubation (extubation time>6 hours).

Variables	Fast track N=282	Non-fast track N=74	p
	Mean (SD) or median [IQR1-IQR3] n (%)	Mean (SD) or median [IQR1-IQR3] n (%)	
Mechanical ventilation time (hours)	0 [0-4]	10 [8-18]	<0.001
Reintubation for respiratory failure	2 (0.7)	3 (4)	0.10
Bleeding re-thoracotomy	6 (2)	9 (12)	<0.001
Cerebral stroke	1 (0.4)	0	0.99
Delirium	13 (5)	5 (7)	0.45
New onset AF (in preoperative SR)	51/212 (24)	12/52 (23)	0.88
ICU stay (hours)	23 [18-28]	40 [24-66]	<0.001
Pre-discharge red blood cells transfusion (number of patients)	49 (17)	25 (34)	0.002
30-day mortality	0	1 (1.3%)	0.47
Hospital stay (days)	7 (4)	9 (5)	0.005
Discharge Home	148 (52)	19 (26)	<0.001

Table 3. Preoperative and intraoperative data of patients who underwent on table extubation and ICU extubation within 6 hours.

Variables	On table extubation N=160	Extubation≤6 hours in ICU N=122	p	[SMD]
	Mean (SD) n (%)	Mean (SD) n (%)		
Age (years)	61 (11)	64 (12)	0.019	0.26
Gender (M/F)	105/55	71/51	0.20	0.17
BMI (kg/m^2)	24.9 (4.2)	24.8 (4.2)	0.90	0.02
COPD	6 (4)	1 (1)	0.23	0.16
CKD (eGFR<50 mL/min/1.73m^2)	16 (10)	21 (17)	0.07	0.21
NYHA class≥III	52 (32)	36 (30)	0.59	0.04
History of AF	35 (22)	35 (29)	0.19	0.16
LVEF (%)	62 (6)	60 (8)	0.05	0.29
Mitral regurgitation	154 (96)	115 (96)	0.43	0
Degenerative MR	149 (93)	101 (84)	0.006	0.28
PAPs≥30 mmHg	58 (36)	42 (34)	0.75	0.04
Tricuspid regurgitation ≥ moderate	39 (24)	29 (24)	0.91	0
EuroSCORE II (%)	1.1 (1.0)	1.3 (1.0)	0.08	0.20
Isolated MV surgery	137 (86)	102 (85)	0.88	0.03

MV repair for MR	149/154 (97)	101/115 (88)	0.005	0.35
Mitral repair for degenerative MR	145/148 (98)	91/102 (90)	0.015	0.34
CPB time (minutes)	98 (25)	103 (28)	0.06	0.19
Cross-clamp time (minutes)	62 (17)	63 (22)	0.69	0.05

AF, atrial fibrillation; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; LVEF, left ventricle ejection fraction; MR, mitral regurgitation; MV, mitral valve; PAPs, systolic pulmonary artery pressure

Table 4. Postoperative data of patients who underwent on table extubation and ICU extubation within 6 hours.

Variables	On table extubation N=160	Extubation≤6 hours in ICU N=122	p
	Mean (SD) or median [IQR1-IQR3] n (%)	Mean (SD) or median [IQR1-IQR3] n (%)	
Mechanical ventilation time (hours)	0	4 [3-5]	-
Reintubation for respiratory failure	0	2 (2)	0.36
Bleeding re-thoracotomy	2 (1)	4 (3)	0.45
Cerebral stroke	0	1 (0.8)	0.89
Delirium	4 (3)	9 (7)	0.10
New onset AF (in preoperative SR)	27/123 (22)	24/87 (28)	0.34
ICU stay (hours)	23 [16-25]	24 [21-35]	0.007
Pre-discharge red blood cells transfusion (number of patients)	26 (16)	23 (19)	0.57
30-day mortality	0	0	-
Hospital stay (days)	7 (4)	8 (4)	0.19
Discharge Home	97 (61)	51 (42)	0.002

Table 5. Multivariable analysis results about the association of fast track and on table extubation management with postoperative stay endpoints.

	Fast track vs Non-fast track*		On table extubation vs Extubation≤6 hours in ICU	
Endpoints	OR [95% CI]	p	OR [95% CI]	p
ICU stay≤1 day	4.67 [2.52-8.69]	<0.001	2.33 [1.21-4.49]	0.011
Hospital stay≤7 days	1.74 [0.96-3.15]	0.07	1.21 [0.69-2.11]	0.49
Discharge home	2.17 [1.13-4.17]	0.020	1.75 [1.02-3.03]	0.043
Discharge home within 7 days	2.22 [1.07-4.64]	0.033	2.20 [1.24-3.91]	0.007

*Four patients in the non-fast track group were excluded from this analysis due to major intraoperative complications (iatrogenic aortic dissection, intraoperative acute myocardial infarction, injury of thyroid cartilage, compromised gas exchange and ventilation)

Figures

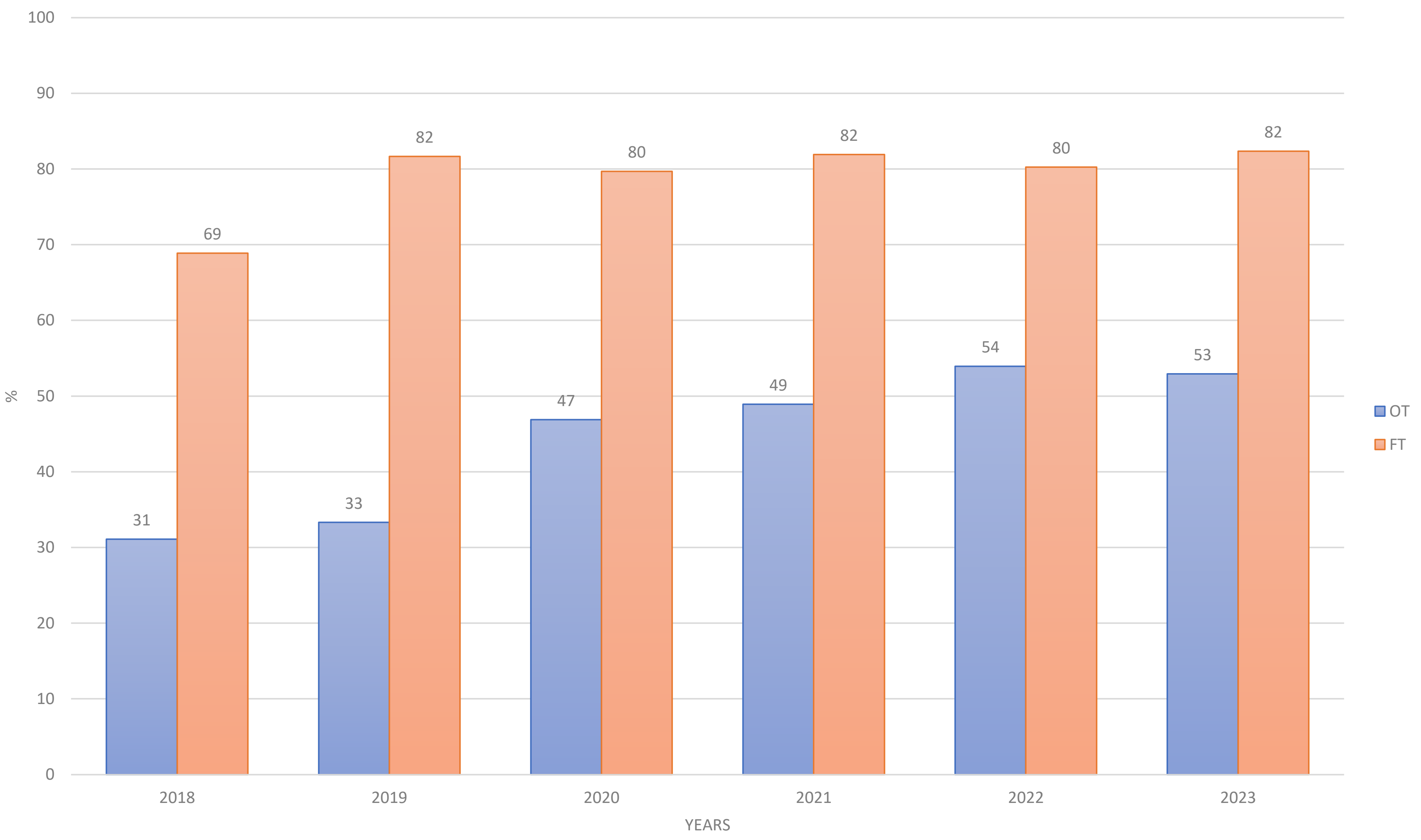
Central Image. (self explanatory)

Figure 1. Design of the study.

Figure 2. Percentage of patients who underwent fast track extubation (FT, $p=0.59$) and on table extubation (OT, $p=0.035$) in each year of the study period.

Figure 3. Percentage of patients who were discharged home with no need of any further period of cardiopulmonary rehabilitation or transfer to medical facilities in each year of the study period ($p=0.002$).

Figure 2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YEARS
OT
FT

Figure 3

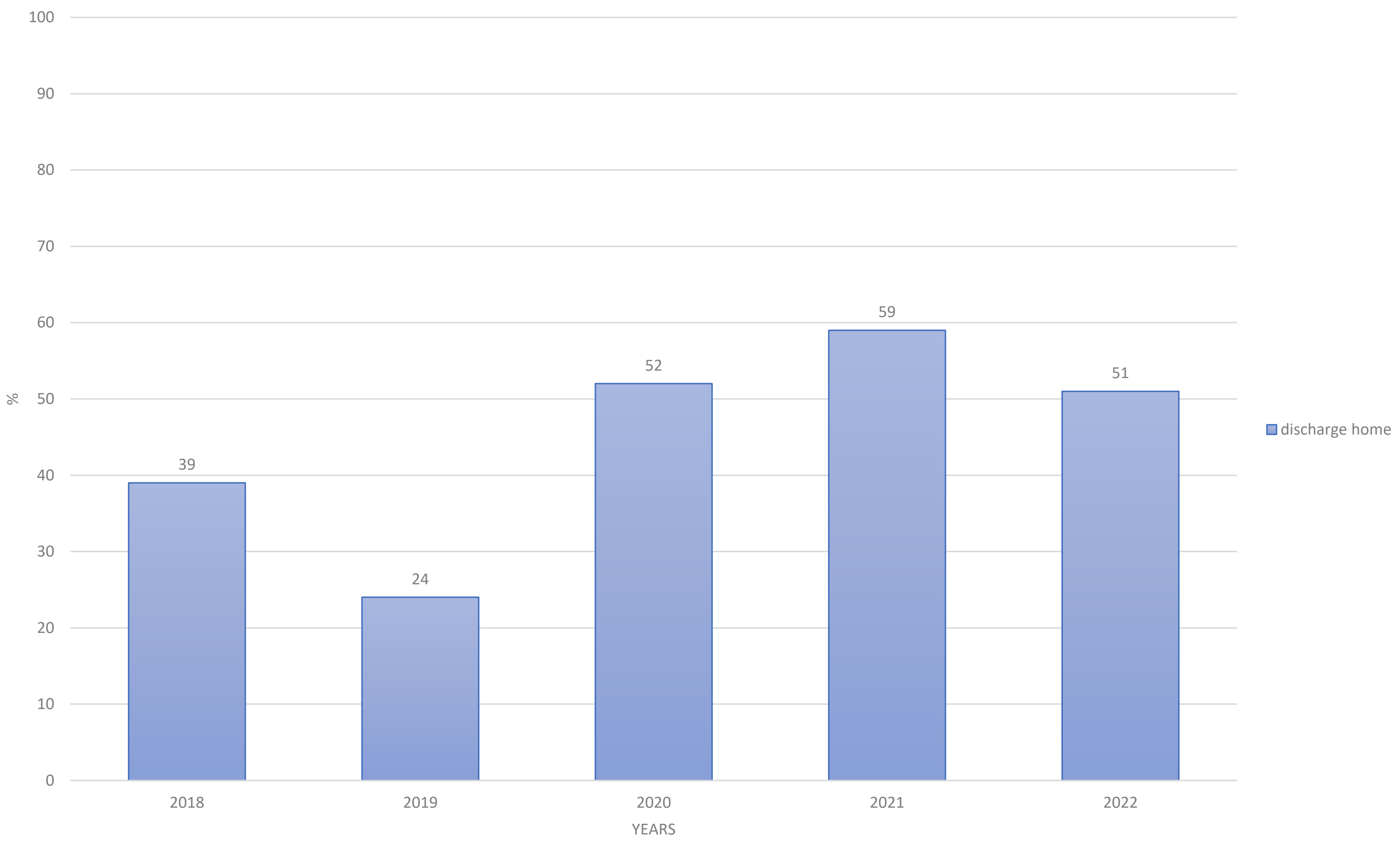
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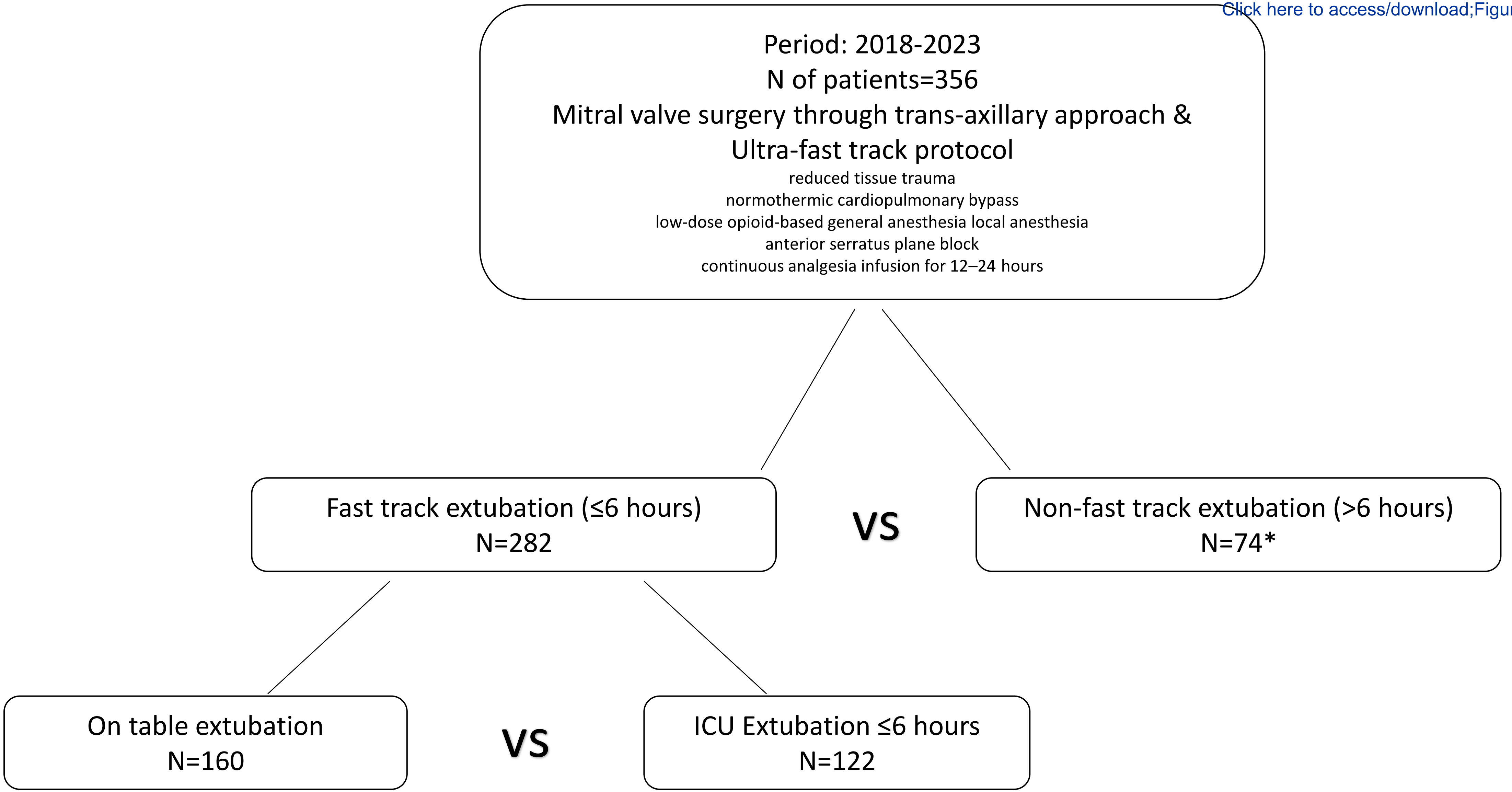
Figure 1



vs
Logreg association between preoperative and operative variables and extubation management
Logreg association between extubation management and ICU stay, hospital length of stay, discharge destination

*two analyses were performed excluding 4 patients who had intraoperative major complications and further 18 patients with early complications after ICU admission

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Supplementary material
calculator.xlsx