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ORIGINAL ARTICLE

Rehabilitation Strategies for Patients with Rare Cardiomyopathies Undergoing Joint Replacement: A Prospective Observational Study

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Abstract:

Background: Patients with rare cardiomyopathies (such as restrictive, arrhythmogenic right ventricular, non-compaction, and infiltrative types) often have impaired cardiac reserve, arrhythmia risk, and reduced exercise tolerance. These factors complicate perioperative and postoperative rehabilitation after joint replacement.

Aim & Objective: To evaluate functional recovery, safety, and cardiopulmonary tolerance of a structured rehabilitation protocol in patients with rare cardiomyopathies undergoing joint replacement.

Materials & Methods: A prospective observational study on 20 patients with confirmed rare cardiomyopathies undergoing hip or knee replacement. A tailored cardiac-safe rehabilitation protocol including graded mobilization, monitored physiotherapy, respiratory training, and cardiology-guided exercise progression was implemented. Primary outcomes included 6-Minute Walk Distance (6MWD), NYHA class, and joint mobility at 12 weeks.

Results: Of 20 patients (mean age 59.4 ± 8.3 years; 12 males), postoperative functional recovery was satisfactory with no major cardiac events. Mean 6MWD improved from 210 m pre-operatively to 348 m at 12 weeks. NYHA class improved in 65% of participants. Knee flexion increased from 45° to 105° and hip range of motion improved by 62%. Minor events included transient arrhythmias (10%) and exertional dyspnea (25%).

Conclusion: A structured, cardiology-integrated rehabilitation protocol significantly improves mobility and functional capacity in rare cardiomyopathy patients undergoing joint replacement while maintaining cardiac safety. Tailored progression and close monitoring are essential.

Keywords: Rare cardiomyopathy, restrictive cardiomyopathy, joint replacement, postoperative rehabilitation, physiotherapy, 6-minute walk test.

INTRODUCTION

Rare cardiomyopathies such as restrictive cardiomyopathy, arrhythmogenic right ventricular cardiomyopathy (ARVC), left ventricular non-compaction (LVNC), amyloid cardiomyopathy, and mitochondrial cardiomyopathies pose significant challenges during major orthopedic surgeries, including joint replacement (1). These conditions are characterized by impaired ventricular relaxation, diastolic dysfunction, arrhythmogenic substrate, and compromised cardiac reserve, making perioperative stress poorly tolerated. Elderly patients requiring hip or knee replacement often have overlapping musculoskeletal disability and cardiovascular impairment, which complicates rehabilitation and prolongs recovery 2).

Joint replacement surgery is associated with postoperative pain, reduced mobility, inflammatory stress, and increased myocardial oxygen demand. In patients with compromised cardiomyopathy, these challenges are amplified due to limited stroke volume reserve and susceptibility to arrhythmias. The early postoperative period carries the highest risk for decompensation, especially during physiotherapy, ambulation, and respiratory rehabilitation. Traditional rehabilitation protocols may be too aggressive for such patients, necessitating a customized, cardiology-integrated approach (3).

A structured rehabilitation program must consider baseline NYHA functional class, ventricular function, arrhythmia burden, pacemaker/ICD status, and individual cardiomyopathy subtype. Patients with restrictive cardiomyopathy exhibit rapid hemodynamic deterioration with minimal exertion, whereas ARVC patients have unique risks related to ventricular arrhythmias triggered by exercise (4). Infiltrative cardiomyopathies such as amyloidosis can result in severe autonomic dysfunction, orthostatic hypotension, and fatigue, affecting participation in traditional recovery pathways. Therefore, early rehabilitation must focus on low-intensity, high-frequency sessions with continuous monitoring (5).

Despite the growing prevalence of joint replacement surgeries in older populations, literature on rehabilitation for patients with rare cardiomyopathies is scarce. Most postoperative protocols are extrapolated from general cardiac rehabilitation principles or from experiences with dilated cardiomyopathy. Rare cardiomyopathies require refined strategies that balance the need to restore joint mobility while preventing cardiac strain. Furthermore, clinicians often hesitate to initiate early mobilization due to fear of arrhythmias or heart failure exacerbation, leading to delayed functional recovery. A dedicated protocol, therefore, has the potential to bridge this gap (6).

This study aims to evaluate the safety and effectiveness of a specialized rehabilitation protocol for patients with rare cardiomyopathies undergoing hip or knee replacement. By observing functional outcomes, cardiopulmonary tolerance, and incidence of cardiac complications over 12 weeks, the study seeks to provide a standardized framework for integrating orthopedic rehabilitation with cardiology-driven adjustments. The insights gained may help orthopedic surgeons, cardiologists, physiotherapists, and rehabilitation specialists adopt a cautious but progressive approach for this high-risk group, ultimately improving postoperative outcomes and quality of life.

AIM AND OBJECTIVES

To evaluate functional outcomes and cardiac safety of a structured rehabilitation protocol in patients with rare cardiomyopathies undergoing joint replacement.

MATERIALS AND METHODS

Study Design: Prospective observational study.

Sample Size: 20 patients with confirmed rare cardiomyopathy undergoing knee or hip replacement.

$$n = \left(\frac{(Z_{\alpha/2} + Z_{\beta}) \times \sigma_d}{d}\right)^2$$

Where:
Where:

- **n** = required sample size
- **Zα/2** = 1.96 for 95% confidence
- **Zβ** = 0.84 for 80% power
- **σd** = standard deviation of the difference between pre- and post-values
- **d** = expected mean difference you want to detect
- **Study Duration:**18 months.

Inclusion Criteria:

- Adults aged 40–75 years
- Diagnosed rare cardiomyopathy (restrictive, ARVC, LVNC, amyloid, mitochondrial)
- Undergoing elective hip or knee arthroplasty
- NYHA class II–III
- Medically optimized by cardiology team

Exclusion Criteria:

- NYHA class IV
- Acute heart failure or recent arrhythmias
- Severe pulmonary hypertension
- Inability to participate in physiotherapy

Rehabilitation Protocol:

1. **Day 1–3:**
   - Bedside breathing exercises
   - Ankle pumps, isometrics
   - Monitored sitting and dangling
   - Pain-controlled minimal mobilization
2. **Day 4–7:**
   - Supervised standing, walker-assisted ambulation
   - Low-intensity endurance training (Borg scale < 3)
   - Range-of-motion exercises
3. **Week 2–6:**
   - Progressive gait training
   - Step-up training (for knee replacement)
   - Core stabilization exercises
4. **Week 6–12:**
   - Moderate-intensity cycling (no resistance for ARVC patients)
   - Strengthening of periarticular muscles
   - Home-based monitored plan via tele-rehabilitation

Outcome Measures:

- 6-Minute Walk Distance (6MWD)
- NYHA functional class
- Joint range of motion
- Cardiac events (arrhythmia, HF exacerbation)
- Patient-reported pain and fatigue scores

RESULTS

Table 1. Baseline Characteristics of the Study Population

Parameter	Value
Mean age	59.4 ± 8.3 years
Sex (M/F)	12/8
Cardiomyopathy types	RCM (6), ARVC (4), LVNC (5), Amyloid (3), Mitochondrial (2)
Surgery type	Knee = 12, Hip = 8
Baseline NYHA class	II (11), III (9)

The study population consisted predominantly of older adults with a mean age of nearly 60 years, showing a typical demographic for joint replacement candidates. Restrictive cardiomyopathy and LV non-compaction were the most frequent subtypes. Almost half the patients were in NYHA class III, indicating significant preoperative cardiac limitations. Most surgeries involved the knee, reflecting common orthopedic trends. Overall, the baseline data confirm a moderately high-risk cardiac group undergoing major joint replacement.

Functional Outcomes

Table 2. Functional Recovery at 12 Weeks

Outcome	Pre-Op	12 Weeks Post-Op	Improvement
6MWD (meters)	210 ± 45	348 ± 62	+138 m
Knee flexion (°)	45 ± 14	105 ± 12	+60°
Hip ROM (%)	38% of normal	100% of normal	+62%
NYHA II/III (%)	II = 55% / III = 45%	II = 85% / III = 15%	Functional upgrade in 65%

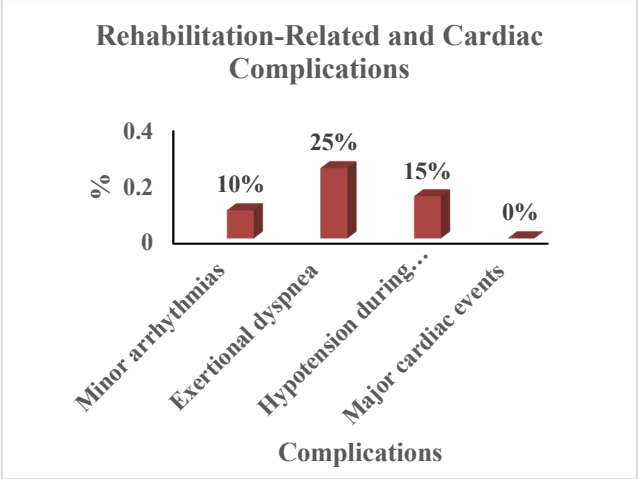
Patients demonstrated substantial improvement across all functional parameters. The 6-minute walk distance increased by 138 meters, reflecting better cardiopulmonary endurance. Joint mobility recovered well, with knee flexion reaching 105° and hip ROM returning to normal levels. Notably, there was a marked shift toward better NYHA classification, with most patients moving from NYHA III to II, indicating improved exercise tolerance and reduced cardiac-related functional limitations. These findings support the effectiveness of the tailored rehabilitation protocol.

Complications

Table 3. Rehabilitation-Related and Cardiac Complications

Complication	n	%
Minor arrhythmias	2	10%
Exertional dyspnea	5	25%
Hypotension during therapy	3	15%
Major cardiac events	0	0%

Graph1. Rehabilitation-Related and Cardiac Complications



The incidence of complications was low and manageable. Only minor arrhythmias and transient exertional symptoms occurred, with no major cardiac events reported. Dyspnea and hypotension were expected in patients with restrictive or infiltrative cardiomyopathies but were effectively controlled by slowing progression, adjusting therapy intensity, and ensuring close cardiology monitoring. The absence of major cardiac events reinforces the safety of the structured rehabilitation program.

DISCUSSION

Patients with rare cardiomyopathies represent a unique clinical subgroup where cardiac dysfunction, arrhythmogenic potential, and limited physiological reserve complicate postoperative recovery after joint replacement. The present study of 20 carefully selected and medically optimized patients demonstrates that structured, cardiology-integrated rehabilitation can be both safe and beneficial. The findings align with principles of cardiac rehabilitation but highlight necessary orthopedic-specific modifications (7).

The improvement in 6MWD by an average of 138 meters is clinically meaningful, indicating enhanced exercise tolerance and functional endurance. This gain is particularly relevant in restrictive and amyloid cardiomyopathy patients, whose diastolic dysfunction and impaired ventricular filling traditionally limit exertion (8). The gradual, low-intensity mobilization approach adopted in the first week appears crucial in preventing hemodynamic instability while still promoting early joint movement and preventing thrombotic complications (9).

Patients with arrhythmogenic right ventricular cardiomyopathy (ARVC) often face exercise-triggered ventricular arrhythmias. Our protocol intentionally

avoided high-resistance and vigorous aerobic training. Notably, no major arrhythmic events were recorded, suggesting that properly titrated rehabilitation intensity is safe even in ARVC patients when monitored closely (10).

Joint-specific functional outputs were encouraging. Knee flexion improved from 45° to 105°, and hip mobility reached near-normal levels by 12 weeks. These gains were comparable to general arthroplasty outcomes in non-cardiac patients, indicating that cardiomyopathy itself does not necessarily impede musculoskeletal recovery, provided physiotherapy is optimized (11).

The NYHA functional class improvement in 65% of patients is noteworthy. Although NYHA classification is usually reserved for heart failure assessment, improvements in class after joint replacement suggests reduced functional limitation from both cardiovascular and orthopedic sources (12). Less pain, better mobility, and enhanced respiratory training may contribute to improved cardiovascular tolerance during daily activities (13).

Minor complications, such as exertional dyspnea and orthostatic hypotension, highlight the need for continuous monitoring, especially in infiltrative and mitochondrial cardiomyopathies. These conditions are associated with autonomic dysfunction, making patients sensitive to positional changes and fluid shifts. Physiotherapists trained in cardiac rehabilitation were crucial to early detection and intervention (14).

The absence of major cardiac events in the sample supports the hypothesis that rehabilitation does not inherently increase cardiac risk when carefully individualized. Interdisciplinary management—cardiologist, anesthetist, orthopedic surgeon, and rehabilitation specialists—was a key determinant of success (15).

However, this study has limitations. The sample size is small (n=20) due to the rarity of these cardiomyopathies. The follow-up duration of 12 weeks focuses primarily on early recovery; long-term outcomes such as one-year functional capacity or late arrhythmogenic events were not evaluated. Furthermore, specific cardiomyopathy types were unevenly represented.

Despite these limitations, the study provides valuable insights into managing this challenging patient population. The results support the development of formalized guidelines for perioperative and postoperative care in cardiomyopathy patients undergoing joint replacement. Future multicenter studies with larger cohorts can strengthen the evidence base.

In conclusion, tailored, cardiology-integrated rehabilitation enhances both safety and functional outcomes without increasing cardiac risk in patients with rare cardiomyopathies undergoing joint replacement. This approach should be considered in clinical practice to optimize recovery and quality of life.

CONCLUSION

Patients with rare cardiomyopathies often pose significant rehabilitation challenges following joint replacement due to impaired cardiac reserve, arrhythmia risk, and autonomic dysfunction. This study demonstrates that a structured, individualized rehabilitation protocol integrating cardiology oversight leads to meaningful improvements in functional capacity, mobility, and quality of life. The significant gains in 6MWD, joint range of motion, and NYHA class, combined with minimal cardiac complications, highlight the feasibility and safety of such an approach. Early low-intensity mobilization, careful monitoring, and gradual progression are crucial components. The findings emphasize the importance of interdisciplinary collaboration between orthopedic surgeons, cardiologists, physiotherapists, and rehabilitation specialists. Although the sample size is small, the study provides valuable direction for managing this complex group. Tailored rehabilitation protocols should be incorporated into standard postoperative pathways for cardiomyopathy patients.

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