

Tricuspid intervention: when to operate on the 'forgotten valve'

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The tricuspid valve, often termed the 'forgotten valve' in cardiology, presents a unique challenge for intervention. Unlike its mitral and aortic counterparts, severe tricuspid regurgitation (TR) frequently progresses silently, leading to advanced right ventricular dysfunction before symptoms prompt evaluation. Deciding when and for whom to intervene is a decision fraught with uncertainty, particularly as transcatheter options emerge alongside established surgical approaches.

KEY TAKEAWAYS

- **The Pivot:** The increasing availability of transcatheter tricuspid valve interventions is forcing a re-evaluation of patient selection criteria.
- **The Data:** There are no large-scale, randomised trials definitively comparing medical management to intervention, or surgical to transcatheter approaches, for isolated severe TR.
- **The Action:** Clinicians must weigh individual patient factors, including symptom severity, right ventricular function, and comorbidities, against the risks and benefits of available procedures, often without clear guideline recommendations.

Tricuspid regurgitation is a common valvular lesion, frequently secondary to left-sided heart disease, pulmonary hypertension, or right ventricular remodelling. Its prevalence increases with age and in patients with heart failure. While mild or moderate TR is often well-tolerated, severe TR can lead to progressive right heart failure, hepatic congestion, renal dysfunction, and ascites, significantly impacting quality of life and prognosis. The insidious nature of its progression means patients often present late, with advanced disease and multiple comorbidities, complicating intervention decisions.

Historically, tricuspid valve surgery has been performed concomitantly with left-sided valve procedures. Isolated tricuspid valve surgery carries a higher operative risk, particularly in patients with severe right ventricular dysfunction or advanced liver disease. This elevated risk has historically led to a conservative approach, with intervention often reserved for symptomatic patients with severe TR refractory to medical therapy, or those undergoing other cardiac surgery. The patient population for isolated tricuspid intervention is typically older, sicker, and has a higher surgical risk profile.

Understanding the Pathophysiology of Tricuspid Regurgitation

The tricuspid valve apparatus is complex, involving the annulus, leaflets, chordae tendineae, and papillary muscles, all interacting with the right ventricle. Functional TR, the most common form, arises from annular dilation and leaflet tethering due to right ventricular enlargement and dysfunction, often secondary to left heart disease or pulmonary

hypertension. Primary TR, caused by intrinsic valve pathology such as rheumatic disease, endocarditis, or trauma, is less common but also requires careful consideration for intervention. The distinction between functional and primary TR is critical for guiding therapeutic strategy, as addressing the underlying cause of functional TR is paramount. Right ventricular function is a key determinant of prognosis in TR. Chronic volume overload from severe TR leads to progressive right ventricular dilation and dysfunction. This can be exacerbated by pulmonary hypertension, creating a vicious cycle. Assessing right ventricular size, function, and remodelling using echocardiography is fundamental. Advanced imaging modalities, such as cardiac MRI, can provide more precise quantification of right ventricular volumes and ejection fraction, which are important for risk stratification and surgical planning. The severity of TR itself, often graded by echocardiography, also plays a role in decision-making, though symptoms and right ventricular response are often more influential.

The Evolving Market of Intervention

For decades, surgical repair or replacement remained the only definitive treatment for severe TR. Surgical repair, typically annuloplasty, is preferred when feasible, especially for functional TR, as it preserves the native valve. Tricuspid valve replacement is reserved for cases with extensive leaflet damage or severe annular dilation unsuitable for repair. The operative mortality for isolated tricuspid valve surgery can be substantial, particularly in patients with advanced right heart failure or significant comorbidities. This high surgical risk has driven the development of less invasive transcatheter approaches.

Transcatheter tricuspid valve interventions are rapidly evolving, offering alternatives for high-surgical-risk patients. These procedures broadly fall into two categories: leaflet coaptation devices and transcatheter valve replacement. Leaflet coaptation devices aim to reduce regurgitation by approximating the tricuspid leaflets, similar to surgical repair. Transcatheter tricuspid valve replacement involves implanting a prosthetic valve within the native tricuspid annulus or a previously placed surgical bioprosthesis. These technologies are still relatively new, and long-term data on durability and efficacy are accumulating. Clinicians considering these options may find the TRISCEND II trial results informative for understanding two-year outcomes in transcatheter replacement.

Patient Selection: A Conundrum

The absence of large, randomised controlled trials comparing medical therapy to intervention for isolated severe TR means that patient selection relies heavily on expert consensus and observational data. Current guidelines generally recommend intervention for symptomatic patients with severe TR who are refractory to optimal medical therapy, particularly if they are undergoing other cardiac surgery. But the decision becomes more complex for isolated severe TR in patients who are symptomatic or show signs of progressive right ventricular dysfunction.

The timing of intervention is critical. Operating too early on asymptomatic patients risks exposing them to procedural complications without clear symptomatic benefit. Operating too late, however, means intervening on patients with irreversible right ventricular damage, pulmonary hypertension, and advanced multi-organ dysfunction, leading to higher perioperative morbidity and mortality. Identifying the 'sweet spot' for intervention is challenging. Factors such as progressive right ventricular dilation, worsening renal function, and increasing liver congestion, even in the absence of severe symptoms, may indicate a need for earlier consideration of intervention. The Oxford Handbook of Cardiology provides a concise overview of these complex decision points.

Risk stratification tools, such as the Society of Thoracic Surgeons (STS) score, can help estimate surgical risk. But these scores may not fully capture the unique risks associated with tricuspid valve surgery, especially in patients with advanced right heart failure. The presence of significant comorbidities, such as severe chronic kidney disease, advanced liver disease, or severe pulmonary hypertension, further complicates the risk-benefit assessment. For patients with systemic right ventricle, tricuspid valve surgery has shown benefits, but this is a distinct population.

The Role of Multidisciplinary Heart Teams

Given the complexity of patient selection, a multidisciplinary heart team approach is essential. This team typically includes cardiologists, cardiac surgeons, interventional cardiologists, cardiac imaging specialists, and anaesthesiologists. The heart team evaluates each patient individually, considering the severity of TR, right ventricular function, symptom burden, comorbidities, and the patient's preferences. The discussion should encompass the risks and benefits of medical therapy, surgical intervention, and transcatheter options. This collaborative approach ensures that all aspects of the patient's condition are considered, leading to a more informed and personalised treatment plan.

Patient shared decision-making is also paramount. Patients with severe TR, particularly those with advanced disease, may have a limited understanding of their prognosis and the implications of intervention. Providing clear, unbiased information about the available treatment options, their potential benefits, and their associated risks is vital for patient autonomy. Decision aids can be valuable tools in this process, helping patients to weigh their options and make choices aligned with their values and goals. The open-label design of many early transcatheter trials is an obvious caveat when discussing outcomes with patients.

Future Directions and Unanswered Questions

The field of tricuspid valve intervention is still in its early stages compared to aortic and mitral valve disease. Key unanswered questions remain. We lack data from large, randomised trials ($n=1000$, 95% CI) comparing medical management to early intervention for isolated severe TR. The optimal timing of intervention, particularly for asymptomatic or mildly symptomatic patients with progressive right ventricular dysfunction, is not yet clear. Long-term durability and efficacy data for transcatheter tricuspid valve devices are also needed. Identifying reliable biomarkers or imaging parameters that predict which patients will benefit most from intervention is an active area of research. The development of more refined risk stratification models tailored specifically for tricuspid valve disease is also necessary. These models should incorporate factors beyond traditional surgical risk scores, accounting for right ventricular function, pulmonary vascular resistance, and the extent of multi-organ dysfunction. As transcatheter technologies continue to advance, future research will likely focus on head-to-head comparisons between different transcatheter devices and between transcatheter and surgical approaches in specific patient populations. The goal is to move towards evidence-based guidelines that provide clearer recommendations for patient selection and timing of intervention, ultimately improving outcomes for patients with severe tricuspid regurgitation.

CLINICAL IMPLICATIONS

The growing availability of transcatheter tricuspid valve interventions presents a genuine dilemma for clinicians. While these less invasive options offer hope for high-risk patients previously deemed inoperable, the lack of definitive comparative data means we are often flying blind. The temptation to intervene simply

because a device exists must be resisted, particularly when the natural history of isolated severe TR is still not fully understood in all patient subsets.

GPs and specialists alike need to be acutely aware of the subtle signs of progressive right heart failure. The 'forgotten valve' often means patients present late, with significant hepatic and renal compromise, making any intervention riskier. Early referral to a multidisciplinary heart team, even for patients with seemingly stable severe TR, is becoming increasingly important to discuss options before irreversible organ damage sets in. For industry, the race to develop and market new tricuspid devices is understandable, but the onus remains on generating robust, long-term data. Without head-to-head trials against medical management or surgical repair in appropriate populations, these devices risk becoming solutions in search of a problem, or worse, being applied to patients who would not genuinely benefit. The field needs less enthusiasm and more evidence.

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