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Case Report

Massive Functional Tricuspid Regurgitation with Right Heart Failure Percutaneously Treated with Triclip System and ECMO Assistance. Two Case Reports

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ABSTRACT

In this report, we present the cases of two elderly patients with massive tricuspid regurgitation (TR) and severe right ventricular (RV) dysfunction causing right heart failure treated with percutaneous TriClip system assisted with veno-arterial extracorporeal membrane oxygenation (VA-ECMO).

Introduction

Functional (or secondary), tricuspid regurgitation (FTR) is one of the most frequent valvular disease and its prevalence and severity increase with age [1,2]. It's mainly related to right chamber remodeling with RV dilatation and/or disfunction and right atrial enlargement secondary to left sided pathologies or surgery, atrial fibrillation or pulmonary hypertension [3]. TR is an independent prognostic factor associated with significant excess of mortality and morbidity [4,5]. Tricuspid valve interventions are crucial to avoid irreversible RV damage and organ-failure. Surgery is recommended, but exact thresholds for indications are not yet been defined and, in isolated secondary tricuspid regurgitation the benefit of surgical correction compared to medical treatment is not well established [6-8]. Therefore, in clinical practice tricuspid interventions are underused and often considered too late when periprocedural mortality and morbidity risk is too high [9,10]. In recent years percutaneous transcatheter tricuspid valve interventions like edge-to-edge tricuspid valve repair have been developed with the aim of providing a less invasive and alternative treatment to surgery in patients with severe TR at high operative risk [11-16]. However, the presence of advanced RV dysfunction or severe pulmonary hypertension represent a limit [17].

Extracorporeal life support, specifically venoarterial extracorporeal membrane oxygenation (ECMO) has been successfully used in patient with RV failure due to elevated pulmonary afterload [18-20]. The potentially role of prophylactic mechanical support, during intervention in particularly complex clinical context as that of tricuspid intervention in advanced right ventricular dysfunction has not been explored. In this report we present two cases of refractory right heart failure due to massive tricuspid insufficiency, severe right ventricular dysfunction treated with percutaneous edge-to-edge tricuspid valve repair during ECMO assistance.

Case Report 1

83-year-old man with hypertension, former smoker, in permanent AF with multiple comorbidities including moderate chronic obstructive pulmonary disease with mixed (obstructive-restrictive) impairment, stage II chronic renal failure, peripheral vascular disease, previous neurosurgery for subdural hematoma. RV dysfunction diagnosis with moderate TR and pulmonary hypertension was performed in 2016. Over the years there was a progressive worsening of tricuspid insufficiency and of the RV dysfunction. In February 2021 he was admitted to the Heart Failure Medicine Unit of our Hospital for right heart failure syndrome characterized by breathlessness, ankle swelling,

fatigue with extreme asthenia, hypotension in maximal tolerated diuretic therapy, hepatic and renal congestive failure. The echocardiography evaluation revealed normal left ventricular systolic function, mild mitral valve disease, pulmonary hypertension (systolic pressure 60 mmHg), severe right ventricular dilatation and dysfunction (basal diameter 4 chamber apical 60 mm, tricuspid annulus 48 mm, TAPSE 13 mm, S wave at TDI 8 cm/sec, FAC 25%) with signs of systemic venous congestion (inferior caval vein diameter 30 mm), and massive tricuspid insufficiency (vena contracta jet regurgitation in 4 chambers 16 mm, EROA 50 mm^2,) due to coaptation deficit extended along the entire rim but prevalent in the postero-septal portion (max coaptation gap 12 mm). (**Figure 1-3**).

During hospitalization the patient underwent coronary angiography which excluded the presence of coronary artery disease and right heart catheterization that demonstrates a mixed

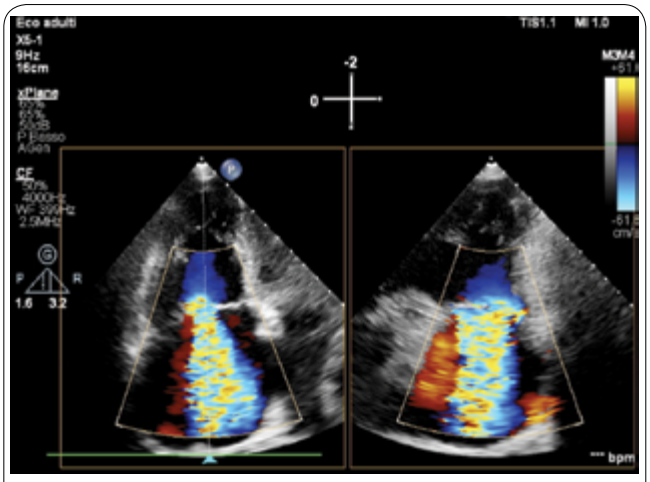

Figure 1: Basal Tricuspid Regurgitation Case 1.

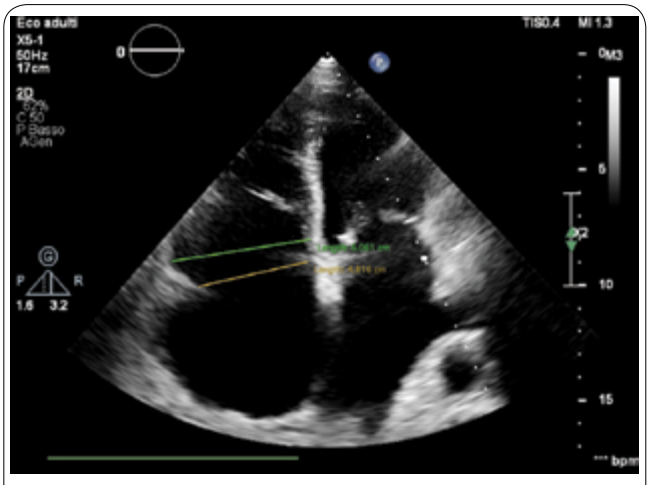

Figure 2: RV and TV annulus dimensions Case 1.

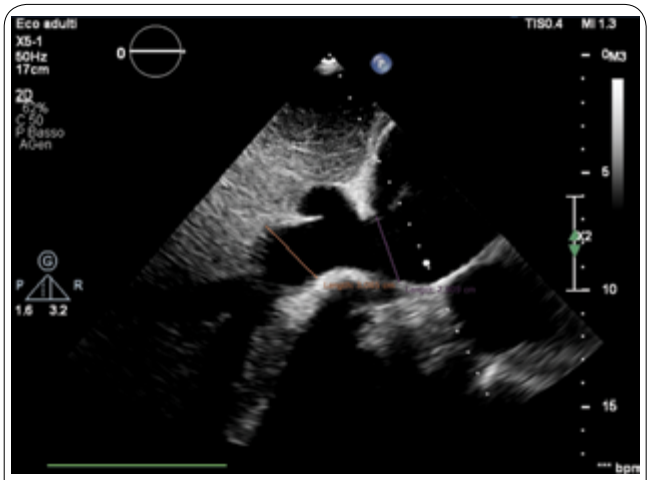

Figure 3: Inferior caval vein dilatation Case 1.

form of pre-capillary and post-capillary pulmonary hypertension (mPAP 30 mmHg, PAWP 18 mmHg, diastolic trans-pulmonary gradient 7, pulmonary vascular resistance 3.5 U/W).

Case Report 2

81 years old woman, with hypertension, previous aortic valve replacement surgery, permanent AF, history of significative tricuspid valve incompetence with right ventricular dilatation in medical treatment. In June 2021 she was admitted to the Heart Failure Medicine Unit of our Hospital for right heart failure syndrome characterized by extreme asthenia, ankle swelling, fatigue, hypotension in maximal tolerated diuretic therapy, hepatic and renal congestive failure. The echocardiography evaluation revealed normal left ventricular systolic function, no dysfunction of the prosthetic aortic valve, mild rheumatic mitral valve disease, moderate pulmonary hypertension (systolic pressure 45 mmHg), severe right ventricular dilatation and dysfunction (baseline diameter 4 chamber apical 60 mm, TAPSE 16 mm, S wave at TDI 8.7 cm/sec, FAC 28%) with signs of systemic venous congestion (inferior caval vein diameter 30 mm), and massive tricuspid insufficiency (vena contracta jet regurgitation in 4 chambers 17 mm, EROA 50 mm^2) due to coaptation deficit extended along the entire rim but prevalent in the antero-septal portion (max coaptation gap 16 mm) (**Figures 4-6**).

During hospitalization the patient underwent coronary angiography which excluded the presence of coronary artery disease and a right heart catheterization that demonstrates a mild pulmonary hypertension (mPAP 20 mmHg, PAWP 10 mmHg, diastolic trans-pulmonary gradient <7, pulmonary vascular resistance <3 U/W).

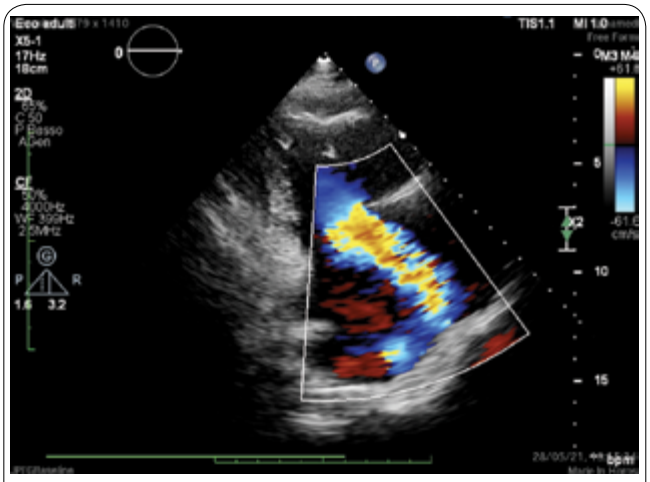

Figure 4: Basal Tricuspid Regurgitation Case 2 .

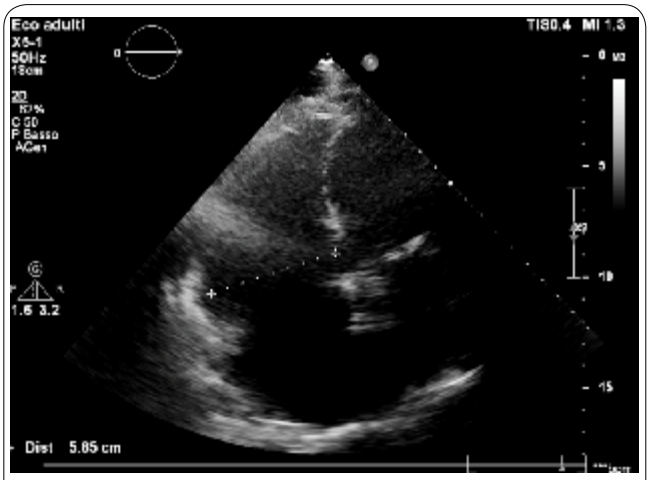

Figure 5: RV dimension Case 2.

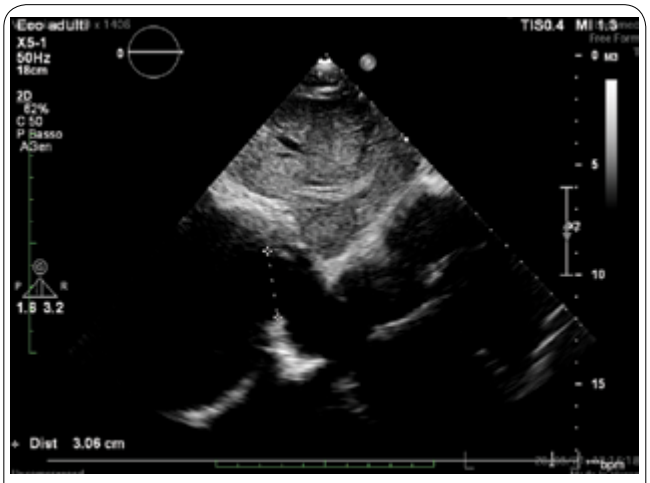

Figure 6: Inferior Caval Vein dilatation Case 2 .

Both cases were discussed in the Heart Team. Considering the high operative risk (Euroscore II 6%, STS score 25% in Case 1, Euroscore II 33%, STS score 10% in Case 2) it was decided a percutaneous approach through the use of TriClip (Abbott) in order to correct the tricuspid defect. Furthermore, it was decided a strategy with percutaneous mechanical assistance through the veno-arterial extracorporeal membrane oxygenation system (VA-ECMO) considering the hemodynamic instability caused by right ventricular failure and the risk of further impairment of the right ventricular function for the afterload change after tricuspid insufficiency correction.

The procedure was performed with assisted ventilation, continuous echo-transoesophageal monitoring, surgical isolation of the femoral vessels in Case 1, percutaneous femoral approach in Case 2 (using Proglide system for hemostasis). The left femoral axis was chosen for the implantation of the VA-ECMO system (ECMOLIFE, - Eurosets, Medolla, Italy), with the placement of a 20 Fr arterial cannula (Fem-Flex II, Edwards Lifesciences, Irvine, CA - USA) and a 22 Fr venous cannula (Rap-Femoral venous cannula, Sorin/Livanova, Saluggia, Italy). To optimize the degree of drainage of the right cavities and allow the manoeuvres necessary for the positioning of the tricuspid clips, the femoral venous cannula was retracted under fluoroscopic guidance at the level of the hepatic veins and a 14 Fr cannula was placed percutaneously in the internal right jugular vein (Medtronic DLP Femoral arterial cannulae, Medtronic, Minneapolis, MN - USA) Y-connected on the venous line. The estimated total theoretical flow for the patient was 4.4 l/min. After administering 200 IU/kg of heparin, the ECMO was started at about 55-60% of the total theoretical flow (about 2.5-3 l/min), checking the degree of drainage of the right ventricle through transoesophageal echocardiography. The 24 Fr delivery catheter for TriClip was introduced into the right atrium via the right femoral vein. By TEE monitoring (multiplane inflow-outflow and transgastric RV projections) were positioned 2 TriClips XT in both cases (postero-septal + antero-septal in Case 1, antero-septal in Case 2) with significant reduction of tricuspid regurgitation (at least two degrees of TR at echo intraoperatory assessment) (**Movie 1**).

Total ECMO time was 150 minutes in the first case and 120 minutes in the second one. Both patients were slowly and gradually weaned from the ECMO at the end of the procedure. ECMO flows was reduced by 25%, every 20 min while inotropic support with Dobutamine 5-7 γ/kg/min was set. Echocardiographic check of tricuspid repair stability and RV function were performed at every stage. The jugular cannula was closed at 25% of ECMO flow, leaving only VA femoro-femoral

support in order to increase RV filling having only inferior vena cava drainage. Then, after checking stability of haemodynamic (systemic and central venous pressure) and echo parameters the ECMO was stopped and after 20 min the cannulas were removed. Left heart function parameters remained unchanged.

The course in ICT was without complications and the patients were transferred to the ordinary hospital ward on the second post-procedural day. Subsequent course was uneventful and both patients maintained a good compensation. Pre-discharged echocardiographic evaluation confirmed the presence of a successful TriClip implant with moderate residual insufficiency in Case 1 (EROA 30 mm^2, Vena contracta 7 mm), mild residual insufficiency in Case 2 (EROA 20 mm^2, Vena contracta 6 mm), reduction of RV dilatation (basal RV diameter in 4 chamber, 54 mm in both cases) and systemic venous congestion (ICV diameter 24 mm – **(Figures 7-9, Movie 2**).

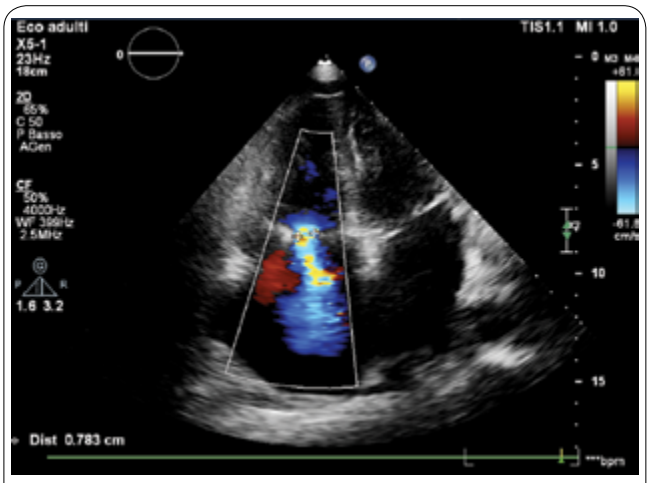

Figure 7: Post Intervention TR, Case 1.

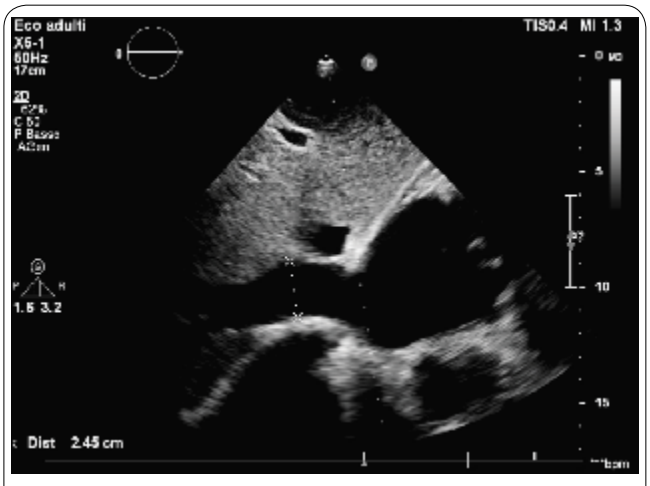

Figure 8: Post Intervention ICV diameter Case 1.

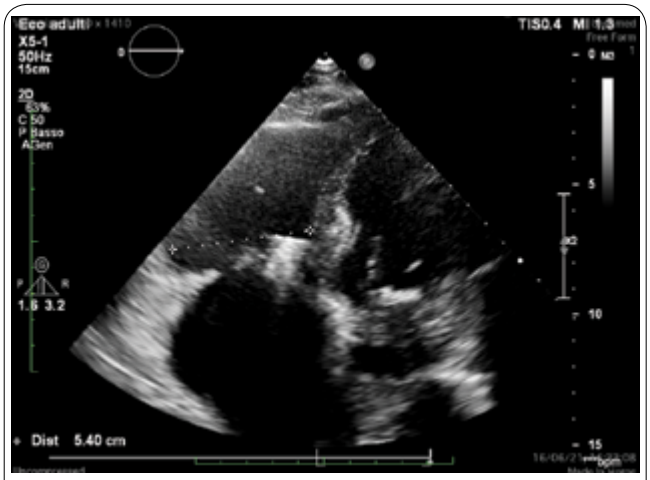

Figure 9: Post Intervention RV diameter, Case 2.

Discussion

FTR is frequent (more than 4% of patients aged 75 years or more), significantly influences outcome and need specific management [1,2]. Medical therapy, mainly diuretics in order to decrease preload, has only palliative effect and intervention is the only curative treatment. Surgical TV repair is recommended but unfortunately FTR is mostly diagnosed very late in the course of the disease when there is end-stage organ damage due to RV dysfunction. Therefore, the mortality rate for isolated TR surgery is still high despite the several different surgical techniques proposed [4-10,17]. New transcatheter less invasively technical solutions (like edge-to-edge tricuspid valve repair) have been developed with the aim to allow treatment in patients with severe TR at high operative risk. Registry and study data had showed clinical and hemodynamic improvement compared to medical treatment in patients symptomatic, inoperable and anatomic eligible [11,16]. However, a severe FTR after optimal medical therapy in the presence of advanced RV dilatation/dysfunction or severe pulmonary hypertension represents a limit to intervention and indication for palliative medical treatments [17].

In this report we have described the positive outcome of a combined strategy of transcatheter massive TR correction with TriClip in VA-ECMO prophylactic assistance for the treatment of two patients with refractory RV failure and candidate to palliative care.

The TriClip system (Abbott) was specifically created for the non-surgical treatment of tricuspid

valve insufficiency through (in analogy to the MitraClip system - Abbott), the implantation of one or more chrome-cobalt-nitinol with polyester coating clips, on the valve leaflet in order to reduce the coaptation deficit.

The VA-ECMO (veno-arterial extracorporeal membrane oxygenation) is a form of temporary mechanical circulatory support and simultaneous extracorporeal gas exchange. It allows to maintain systemic pressure and oxygenation, unloading RV. It has been effective in contest of acute RV failure due pulmonary hypertension but also in chronical setting with RV failure during initiation of pulmonary vasodilator therapy [18-20]. More recently the use of ECMO has been proposed as prophylactic support during percutaneous complex cardiac intervention especially in high-risk patients [21]. The potentially role of prophylactic mechanical support, during tricuspid intervention in advanced right ventricular dysfunction and critical clinical condition has not been explored. The two patients presented in this report showed a similar extreme critical condition with the difficult balance between the medical therapy and the hemodynamic instability and the organ damage caused by systemic venous congestion typical of severe RV failure due to massive TR. Furthermore, the FTR was anatomically characterized in both, by the presence of a huge coaptation gap beyond the grasping limit of the device. In this critical setting the choice of the VA-ECMO assistance was particularly effective since it made technically easier and strong the grasping through a carefully modulation of right ventricular preload and made more stable the hemodynamic favouring the RV adaptation to the new anatomical setting in which the TR correction inexorably can cause an increase of the afterload. A carefully balance between ECMO ventricular drainage and the clip coaptation gap reduction is mandatory in order to achieve a significant improvement of tricuspid regurgitation and to avoid the risk of device detachment and leaflet tearing with restoration of a greater ventricular volume after the ECMO weaning.

To our knowledge, this is the first time of such combined procedure for the treatment of massive tricuspid insufficiency in RV failure.

Conclusions

In conclusion, this case shows how a prophylactic use of ECMO can be safe and effective in the percutaneous treatment of a massive FTR due to a RV failure.

Disclosure

None

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