IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 21, Issue 3 Ser.11 (March. 2022), PP 01-05
www.iosrjournals.org

Transcatheter aortic valve implantation (TAVI) for the treatment of aortic stenosis and regurge , Literature Review

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Abstract
Native aortic valve regurgitation (NAVR) is an off-label indication for aortic valve graft implantation using current generation TAVI devices. The standard of care remains aortic valve replacement surgery (AVR). Conclusively TAVR procedure is vital in treating the patient with aortic stenosis since it is minimally invasive and has developed into a successful treatment procedure. The process of improvement of the procedure has led to the breakthrough of the technique from clinical trials into day-to-day practice. CT and X-ray also play a vital role in TAVR procedure as it helps visualize and locate stenosis in the aortic valve before the actual procedure begins.

Key Words: *Native aortic valve regurgitation, aortic valve graft, infective endocarditis , transcatheter aortic valve implantation*

Date of Submission: 15-03-2022 Date of Acceptance: 29-03-2022

I. Introduction:

Transcatheter aortic valve transplantation (TAVI) has developed into a standard of care for inactive patients with symptomatic aortic stenosis and an alternative to open surgery in at-risk patients. Current evidence from randomized controlled trials confirms that TAVI is comparable to aortic valve replacement (AVR) surgery in at-risk patients, has a mortality benefit compared to optimal medical treatment, and appears to be a cost-effective procedure. Since the first TAVI case was performed in 2002, the number of operations worldwide on vascular valve transplantation has steadily increased, but severe aortic failure is still contraindicated for TAVI. Native aortic valve regurgitation (NAVR) is an off-label indication for aortic valve graft implantation using current generation TAVI devices. The standard of care remains aortic valve replacement surgery (AVR). Nevertheless, some patients have been treated with TAVI for NAVR. Some next-generation TAVI devices have design features that can make TAVI for this indication an attractive treatment option for at-risk patients in surgery.

II. Analysis / Discussion:

Ineffective Endocarditis

Whether from bacteria, viruses, or fungus, infection is the main cause of infective endocarditis. The key goal is to keep these germs out of the bloodstream, where they could cause damage to the valves. Cardiovascular, noncardiac, and procedural risk factors all exist. Patients having a history of endocarditis, prosthetic valves, acquired valve disease, or cardiac abnormalities are at higher risk (Lewis, Bucher, Heitkemper, Harding, Kwong, Roberts, 2017). Patients who receive dialysis are also in danger because it is an invasive technique that allows bacteria to enter the circulation. It's also worth noting that people who abuse IV drugs are just as vulnerable, if not more so because they frequently use filthy needles and have little regard for infection control. Patients will present with signs and symptoms of widespread infection, including but not limited to: fever, chills, weakness, malaise, lethargy, and anorexia, which can make diagnosing infective endocarditis difficult (Lewis et al., 2017). Vascular symptoms include splinter haemorrhages in the nail beds petechiae, especially on the conjunctivae, lips, mouth, ankles, feet, around the elbows, and at the back of the knee are specific clinical manifestations that nurses should be aware of. Osler's nodes, Janeway's lesions, and Roth's patches can also be identified as infectious endocarditis. There could be a new systolic murmur or a worsening of an existing systolic murmur in the cardiac system.

When it comes to infective endocarditis, prevention is the gold standard. Thus, all those involved in the care of patients at risk should make it a top priority. When delivering care, the respiratory team must be mindful of the danger of pathogen introduction and use an aseptic procedure. Dentists must also be aware that intrusive techniques, such as manipulation of the oral mucosa, can exacerbate an infection. Before and after dental

treatments, the patient's necessity for prophylactic antibiotic therapy should be stressed. Infected skin exposes the bloodstream to infection, hence wound care is very important in prevention. Nurses have a key role in the clinical context because they are the ones who can check for signs and symptoms of infection. Nurses must utilize their critical thinking abilities because fever is typically absent in the elderly population, leading to infection being undetected. Physical therapists should encourage patients to engage in modest activity when there is no temperature and not in distress.

Process of Improvement

In the 1980s, a less invasive technique was developed, aortic balloon valvuloplasty (BAV), that enlarges the native valve using a standard catheterization technique. This technique was adopted with enthusiasm, but with time it progressively declined due to significant early limitations of valve restenosis where BAV appeared only to provide temporary relief (Cribier, 2016). The percutaneous aortic valve concept was then developed from BAV after the issues of early restenosis in the BAV concept. The technique involved the placement of an expandable balloon stent frame within the calcified native valves. To validate the idea, an autopsy study was conducted on 12 cases of calcific aortic stenosis in Rouen in 1994. The study demonstrated the efficacy of 23mm in diameter expendable peripheral artery balloon stent in maintaining a circular opening in narrowed aortic valve. The study also helped establish the ideal measurements of the stent to avoid any contact with surrounding organs.

Furthermore, the stent requires a high adhesion force to reduce the risk of device embolization by dislodging from the annulus (Cribier, 2016). The concept faced rejection from many companies due to its association with major clinical issues such as stroke, bleeding, coronary occlusion, and permanent auriculo-ventricular block. A start-up company' Percutaneous Valve Technologies, was formed in 1999 to accomplish the project. The company worked with a small biomedical company with great engineers from Israel, which created a durable, strong, and successful collaboration between engineers and clinicians. The partnership led to developing a successful TAVR with sufficient strength, low profile, and durability (Cribier, 2016). The TAVR was then used in various trials from animal to clinical trials, from worktable to bedside, from bedside to probability trials, and from feasibility trials to more extensive clinical and evidence-based trials. The procedure was used from trial to day-to-day practice in treating aortic stenosis.

Diagnosis and Management

Duke criteria are the most commonly used diagnostic criteria for endocarditis diagnosis. The process involves determining bacteremia using blood culture isolates. The second way of diagnosis is echocardiography. Transthoracic echocardiogram (TTE) and transesophageal echocardiography (TEE) are two of them (TOE). TTE is a non-invasive procedure with low sensitivity but good specificity, whereas TTE is an invasive method with up to 95% sensitivity. In general, the TOE is less expensive (Thuny, 2012). The goal of treatment is to eliminate the causative bacteria and the problems that occur, such as those affecting the CNS, kidneys, lungs, and spleen. Antibiotics are used after a proper diagnostic technique in evidence-based infective treatment. Antibiotics are still the most common treatment for infectious endocarditis. The treatment for native valve endocarditis includes a synergistic combination of penicillin G and Gentamicin. The emergence of MRSA has necessitated the use of Vancomycin as first-line therapy. Vancomycin and gentamicin are used to treat prosthetic valve endocarditis. These two drugs work together to prevent rifampin resistance. Substituting linezolid for Vancomycin in patients with renal impairment has been recommended. Patients with Vancomycin sensitivity should be treated with linezolid or daptomycin. According to the American Heart Association, the following criteria should be followed. Other treatment options for people with acute or subacute infective endocarditis include oxygen therapy. Heart failure treatment with medications like ACE inhibitors improves prognosis in all degrees of heart failure and should be utilized as first-line therapy in all patients with heart failure symptoms. Patients with renal insufficiency should be put on haemodialysis (Baddour, 2015).

As recently referenced, infective endocarditis is brought about by contamination in the blood which taints the endocardium. The microbes can enter the circulatory system through intrusive methods like a medical procedure, colonoscopy, endoscopy, dental methodology, and intravenous illicit drug use. Endocarditis can likewise be a significant reason for a typical sickness that youngsters frequently contract, strep. At the point when a patient has the streptococci microorganisms and it is left untreated, rheumatic fever can happen. Endocarditis is a genuine inconvenience to rheumatic fever. Individuals in danger for endocarditis frequently have an inclining heart condition, for example, intrinsic heart abandons, mitral valve prolapse, and atrial valve prolapse. On the off chance that a patient is known to have a danger of endocarditis, the patient is generally treated with prophylactic anti-toxins before obtrusive systems and dental work. Around most endocarditis cases are left-sided endocarditis, which is in the mitral or aortic valve. Around a modest amount of endocarditis cases are correct sided endocarditis, which is tricuspid or pulmonic valve. Right-sided endocarditis is most ordinarily brought about by intravenous chronic drug use. "Past examinations dependent on nearby case series assessed the

yearly occurrence of endocarditis in the U.S. at around 4 for every 100,000 populace". Endocarditis is more common in non-industrial nations.

Aortic Valve Replacement

Aortic valve replacement is a surgical procedure done to correct heart illness affecting the aortic valve. The primary function of this valve is to ensure blood flows in the right direction through the heart by separating the left ventricle and the aorta, which is the main artery supplying oxygenated blood to the entire body. In essence, the left ventricle is the "main pumping chamber" of the heart. The aortic valve opens following the left ventricle contraction, enabling blood to move from the chamber to the aorta. The aortic valve closes upon ventricle relaxation, preventing the blood from moving back into the ventricle. In an event where the aortic valve is not functioning well, it can affect the blood flow, compelling the heart to pump harder to supply blood to the whole body (Mack et al., 2013). The replacement of the aortic valve treats aortic heart condition and assists in reinstating usual blood flow, diminishing symptoms, extending life, and helping preserve the heart muscle function. Generally, an aortic valve replacement entails removing a damaged or faulty valve and substituting it with a new valve made from animal tissue or synthetic materials. Since it is a significant operation, this procedure is not suitable for everyone because patients can take longer to recover after the operation. Two conditions may warrant the replacement of the aortic valve: "aortic stenosis" and "aortic regurgitation." Aortic stenosis is the narrowing of the valve. Here, the opening of the valve tightens, interfering with the outflow of the blood.

On the other hand, aortic regurgitation is the leaking of the valve, allowing blood to flow back into the heart (Mack et al., 2013). These conditions worsen over time, and in serious cases, they can result in heart failure if not corrected. Regrettably, there exist no medications for treating aortic valve conditions; therefore, replacement is the only remedy. However, various surgical techniques can be used for the replacement, some of which are minimally invasive (Badhwar et al., 2021). Examples of these techniques include “robotic-assisted aortic valve surgery” and “transcatheter aortic valve replacement (TAVR).”

TAVR is a form of "minimally-invasive surgery." Minimally invasive surgery implies that the process employs smaller incisions than conventional surgery; thus, recovery is easier and faster. With smaller incisions, cardiac surgeons use robotic devices to replace a faulty aortic valve. Special instruments are attached to the robot, which the surgeon inserts them and a camera through these small incisions. The surgeon looks at the surgery through a highly magnified image and controls the robot's movements using a computer (Webb & Wood, 2012). The robotic instruments assist the surgeon in performing the surgery more precisely than they could with the usual tools. This procedure is sometimes referred to as "da Vinci surgery" in reference to the robot's manufacturer usually used for the procedure. According to Balkhy et al. (2020), the primary benefit of this surgery is its minimal invasiveness, resulting in minimal risks and faster healing compared with traditional open-heart surgery. For instance, it is unnecessary to cut through the breastbone to open the patient's chest, eradicating the numerous complications associated with open-heart surgery. However, this procedure does not eliminate other risks based on underlying medical conditions. Although robots have assisted in cardiac surgery like mitral valve repair surgery for the past two decades, their use for aortic valve replacement procedures has been minimal (Webb & Wood, 2012). However, that is now changing as research demonstrates satisfactory results from successful aortic valve replacements using robots. The other technique is the TAVR, a minimally invasive cardiac surgery to replace aortic valves in conditions like valve stenosis. In this heart condition, aortic valves become thickened and cannot fully open causing the heart to pump harder to push blood to the whole body. Presentations of aortic stenosis include fatigue, fainting, breath shortness, and chest pains. TAVR can assist in reinstating normal blood flow and decreasing these symptoms (Nagaoka et al., 2020). TAVR provides an ideal alternative for high-risk individuals of open-heart surgery or surgical aortic valve replacement complications. TAVR patients often have reduced hospital stays compared with their counterparts who undergo open-heart surgery. According to Makkar et al. (2020), TAVR is highly suggested for individuals with severe symptomatic aortic stenosis, a biological tissue valve that is not working as intended, and other health conditions like kidney or lung illness that make open-heart surgery a dangerous affair. Like all other medical procedures and surgeries, TAVR comes with potential risks, including death, infection, heart attack, renal disease, arrhythmias, stroke, regurgitation, blood vessel complications, and excessive bleeding (Webb & Wood, 2012). However, research has shown that risks of death and disabling stroke are similar across all patients undergoing any form of aortic replacement surgery. There is scarce data on clinical outcomes and the function of replaced valves following TAVR compared to robotic-assisted aortic valve replacement in individuals with intermediate surgical risk and serious aortic stenosis. Therefore, this review aims at comparing these dynamics on different groups of patients. A better understanding of the long-term clinical outcomes and the function of replaced valves following TAVR compared to robotic-assisted aortic valve replacement can be obtained by reviewing Makar et al. (2020) and Yanagawa et al. (2015).

Rising cases of heart conditions are being reported. Similarly, new surgical techniques of aortic valve replacement are emerging, which can be attributed to the advances in technology. Therefore, there is a rising

interest in understanding the outcomes and implications of each technique. Makkar et al. (2020) compared the outcomes of TAVR and surgical aortic replacement surgery in severe symptomatic aortic stenosis patients at average risk for surgery. On the other hand, Yanagawa et al. (2015) more specifically compared mortality, actual cost, length of stay, and complications between robotic-assisted and nonrobotic cardiac surgery operations. TAVR and robotic-assisted aortic replacement surgeries are taking over as ideal options for surgical aortic replacements for patients with symptomatic aortic stenosis. Both studies add invaluable data to the existing research on aortic valve replacement surgeries. Although Yanagawa's investigation did not focus specifically on aortic valve replacement surgeries, the study still assists in showing the relevance of robotic-assisted heart surgery compared to nonrobotic, including open-heart surgery. Makkar's research found insignificant differences in the occurrence of death from disabling stroke or any other cause between the TAVR group and surgery group at five years. However, the TAVR group exhibited slightly higher incidences of death, high repeat hospitalization, and high aortic valve interventions at five years compared to the surgery group. Generally, health status improvements at five years were similar for both groups. Yanagawa's study found that robotic-assisted aortic replacements are preferable to open-heart surgery for various reasons, including easier and faster healing, the performance of the valve, reduced risks, reduced length of stay, reduced complications, and reduced mortality, among others. These attributes can be attributed to the minimal invasiveness of this technique (Makkar et al., 2020). This aortic replacement surgery technique is also safer than open-heart surgery and provides the surgeons with additional techniques for heart surgery. Despite the benefits associated with robotic-assisted heart surgery, Yanagawa et al. (2015) found a higher median cost than non-robotic surgery.

Implication for Patient Care

The implication of TAVR in a patient with high risk has been confirmed through several performed randomized clinical experiments. TAVR procedure has demonstrated non-inferiority in patients with low risks compared to surgical aortic valve replacement, supporting the expansion and increased utilization. In patients with a low risk of aortic stenosis, the use of TAVR has vital implications. It requires a multidimensional approach that includes careful data collection for continual outcome assessment, understanding, and mitigation of critical complications such as stroke and a multidisciplinary heart team for careful patient selection (Tuzcu & Edris, 2020). The procedure allows those who cannot be treated by surgical aortic valve replacement procedures or low-risk patients to undergo life-saving. Stroke remains a significant problem in TAVR procedures even after improving the technique and increases in operational experienced. To help protect patients from stroke, proper procedure and follow-up should be done after treatment (Butala et al., 2021). Patient assessment before and after treatment is a vital thing that helps prevent stroke in patients who have been treated for aortic stenosis.

How X-ray and CT are used in TAVR Procedure?

X-ray is an imaging technique that utilizes radiation to visualise body tissues and organs. An X-ray scan for TAVR is used to examine the heart, including the aortic valve and the aorta (Vernikouskaya et al., 2018). The x-ray is not efficient as it lacks a more extensive dynamic range of x-ray sources and its poor resolution of soft tissue; hence CT is highly recommended. CT scan is a technique that uses a computer and x-ray to produce detailed structural information of your body. This technique has a larger dynamic range of x-rays and visualizes both soft tissues and bones. CT scan for TAVR is used to provide detailed information of your heart, including the aortic valve and aorta. CT scan has a greater contrast resolution and provides clear images of the aortic valve in case of aortic stenosis (Vernikouskaya et al., 2018). CT provides detailed information about aortic annulus anatomy and geometry compared to a twodimensional imaging technique, supporting prosthesis sizing and patient selection.

III. Conclusion:

Conclusively TAVR procedure is vital in treating the patient with aortic stenosis since it is minimally invasive and has developed into a successful treatment procedure. The process of improvement of the procedure has led to the breakthrough of the technique from clinical trials into day-to-day practice. CT and X-ray also play a vital role in TAVR procedure as it helps visualize and locate stenosis in the aortic valve before the actual procedure begins.

The early introductions of infective endocarditis can frequently be exceptionally vague and wide. As a rule, patients with infective endocarditis present to crisis offices with fever, chills, night sweats, and in some cases chest torments. Since infective endocarditis is certainly not an exceptionally normal sickness that patients contract, it can regularly be disregarded in the beginning phases. In the crisis division, tests that are performed may not highlight infective endocarditis. Normal tests that are acted in the crisis division for the introducing side effects are regularly lab work, urinalysis, chest x-beam and potentially a processed tomography examine, contingent on introducing indications and requesting doctor. Infective endocarditis won't be principally displayed with the consequences of the recently expressed analytic tests. Patients might be disregarded and

misdiagnosed with the normal cold or influenza. Blood societies in the crisis office ought to uncover what sort of creature is liable for the ailment. Patients might be treated for the contamination, however impacts of infective endocarditis will in any case be predominant. This makes diagnosing infective endocarditis extremely hard in the beginning phases, which implies the illness will frequently advance.

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Altaf Rashad Ashour. "Transcatheter aortic valve implantation (TAVI) for the treatment of aortic stenosis and regurge , Literature Review." *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*, 21(03), 2022, pp.01-05.