

# ROSS PROCEDURE CLINICAL OUTCOMES

Developed in 1967, the Ross procedure replaces the diseased aortic valve with the patient's pulmonary valve, eliminating the need for anticoagulation. A pulmonary allograft is then used to reconstruct the right ventricular outflow tract (RVOT). Though technically challenging, the Ross procedure is associated with long-term durability with physiological hemodynamic function.<sup>1</sup>

## ANTICOAGULATION AVOIDANCE

The Ross procedure “meets an unambiguous need for a durable valve alternative without the lifestyle restraints and risks inherent to permanent anticoagulation.”<sup>2</sup>

## LOW LONG-TERM MORBIDITY

Compared to AVR, the Ross procedure has resulted in lower rates of reintervention, anticoagulation-related morbidity, endocarditis, and all-cause mortality with excellent survival of up to 25 years.<sup>3-5,7</sup>

## LONG-TERM RESTORED SURVIVAL

The Ross procedure “restores a normal life expectancy to young and middle-aged adults”, comparable to that of the general population, whereas AVR has been associated with an estimated 30% reduction in life-expectancy.<sup>7</sup>

## TESTIMONIALS

“Not only was survival better than after biological or mechanical aortic valve replacement, it was also identical to the matched U.S. general population. *To this day, this is the only operation that has ever been shown to restore survival after aortic valve replacement in young adults.*”<sup>28</sup>

— Ismail El-Hamamsy, MD, PhD and Randall B. Griepp, MD, PhD

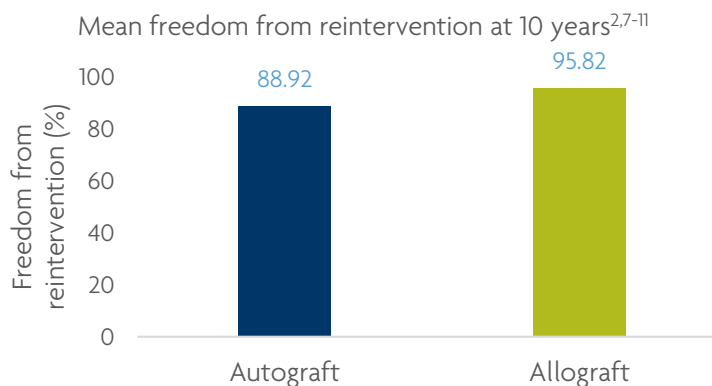
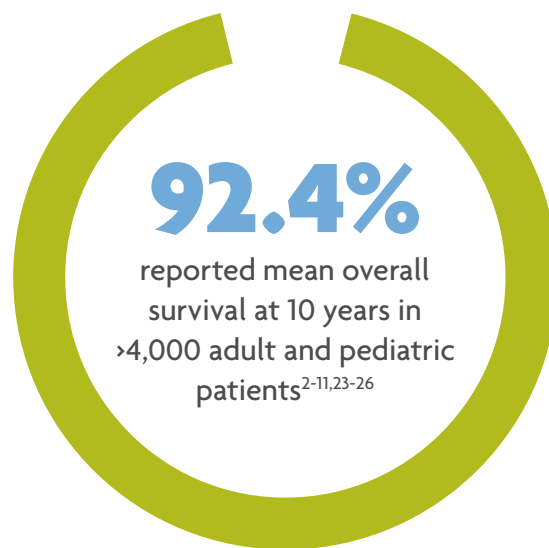
“Within 15 years after the operation, [on the aortic valve] only about 30% of patients will require a reoperation and on the pulmonary valve, if the operation is done correctly in the way that it was originally described, *less than 2% of patients will require a reoperation...*”<sup>29</sup> — Michael Ibrahim, MD, PhD

“*I really believe [the Ross procedure] is the best way of treating a younger patient with aortic disease.*”<sup>30</sup>

— Peter Skillington, MD, PhD

## PUBLISHED CLINICAL EVIDENCE

The Ross procedure has a long history of success and used in **>12,000 adult and pediatric patients (age range 2 days–68 years old)** in multiple clinical studies.<sup>1-28</sup>



Note: Autograft was used in the aortic position and an allograft pulmonary heart valve (cryopreserved or decellularized) was used in the pulmonary position.

# ROSS PROCEDURE CLINICAL EVIDENCE

## REFERENCES

1. Flynn CD, De Bono JH, Muston B, Rattan N, Tian DH, Larobina M, O'Keefe M, Skillington P. Systematic review and meta-analysis of long-term outcomes in adults undergoing the Ross procedure. *Ann Cardiothorac Surg.* 2021 Jul;10(4):411-419. doi: 10.21037/acs-2021-rp-30.
2. Romeo, J. L., Papageorgiou, G., Da Costa, F. F., Sievers, H. H., Bogers, A. J., El-Hamamsy, I., ... & Mokhles, M. M. (2021). Long-term clinical and echocardiographic outcomes in young and middle-aged adults undergoing the Ross procedure. *JAMA cardiology*, 6(5), 539-548.
3. Aboud, A., Charitos, E. I., Fujita, B., Stierle, U., Reil, J. C., Voth, V., ... & Ensminger, S. (2021). Long-term outcomes following the Ross procedure. *Journal of the American College of Cardiology*, 77(11), 1412-1422.
4. Mazine, A., David, T. E., Stoklosa, K., Chung, J., Lafreniere-Roula, M., & Ouzounian, M. (2022). Improved outcomes following the Ross procedure compared with bioprosthetic aortic valve replacement. *Journal of the American College of Cardiology*, 79(10), 993-1005.
5. Andreas, M., Wiedemann, D., Seebacher, G., Rath, C., Aref, T., Rosenhek, R., ... & Kocher, A. (2014). The Ross procedure offers excellent survival compared with mechanical aortic valve replacement in a real-world setting. *European Journal of Cardio-Thoracic Surgery*, 46(3), 409-414.
6. Oeser, C., Uyanik-Uenal, K., Kocher, A., Laufer, G., & Andreas, M. (2019). Long-term performance of pulmonary homografts after the Ross procedure: experience up to 25 years. *European Journal of Cardio-Thoracic Surgery*, 55(5), 876-884.
7. Ryan WH, Squiers JJ, Harrington KB, Goodenow T, Rawitscher C, Schaffer JM, DiMaio JM, Brinkman WT. Long-term outcomes of the Ross procedure in adults. *Ann Cardiothorac Surg.* 2021 Jul;10(4):499-508. doi: 10.21037/acs-2021-rp-fs-28.
8. David, T. E., Ouzounian, M., David, C. M., Lafreniere-Roula, M., & Manlihot, C. (2019). Late results of the Ross procedure. *The Journal of thoracic and cardiovascular surgery*, 157(1), 201-208.
9. Karaskov, A., Sharifulin, R., Zheleznev, S., Demin, I., Lenko, E., & Bogachev-Prokhopiev, A. (2016). Results of the Ross procedure in adults: a single-centre experience of 741 operations. *European Journal of Cardio-Thoracic Surgery*, 49(5), e97-e104.
10. Kouchoukos, N. T., Masetti, P., Nickerson, N. J., Castner, C. F., Shannon, W. D., & Dávila-Román, V. G. (2004). The Ross procedure: long-term clinical and echocardiographic follow-up. *The Annals of thoracic surgery*, 78(3), 773-781.
11. Martin, E., Mohammadi, S., Jacques, F., Kalavrouziotis, D., Voisine, P., Doyle, D., & Perron, J. (2017). Clinical outcomes following the Ross procedure in adults: a 25-year longitudinal study. *Journal of the American College of Cardiology*, 70(15), 1890-1899.
12. Fricke TA, Skillington PD, Shi WY, et al. Pulmonary Valve Function Late After Ross Procedure in 443 Adult Patients. *Ann Thorac Surg* 2020;109:1127-31.
13. David, T. E., David, C., Woo, A., & Manlihot, C. (2014). The Ross procedure: outcomes at 20 years. *The Journal of thoracic and cardiovascular surgery*, 147(1), 85-94.
14. Buratto, E., Shi, W. Y., Wynne, R., Poh, C. L., Larobina, M., O'Keefe, M., ... & Skillington, P. D. (2018). Improved survival after the Ross procedure compared with mechanical aortic valve replacement. *Journal of the American College of Cardiology*, 71(12), 1337-1344.
15. Chauvette, V., Bouhout, I., Lefebvre, L., Tarabzoni, M., Chamberland, M. È., Poirier, N., ... & El-Hamamsy, I. (2020). The Ross procedure is a safe and durable option in adults with infective endocarditis: a multicentre study. *European Journal of Cardio-Thoracic Surgery*, 58(3), 537-543.
16. Mastrobuoni, S., de Kerchove, L., Solari, S., Astarci, P., Poncelet, A., Noirhomme, P., ... & El Khoury, G. (2016). The Ross procedure in young adults: over 20 years of experience in our Institution. *European Journal of Cardio-Thoracic Surgery*, 49(2), 507-513.
17. Andreas, M., Seebacher, G., Reida, E., Wiedemann, D., Pees, C., Rosenhek, R., ... & Laufer, G. (2014). A single-center experience with the Ross procedure over 20 years. *The Annals of thoracic surgery*, 97(1), 182-188.
18. Charitos, E. I., Takkenberg, J. J., Hanke, T., Gorski, A., Botha, C., Franke, U., ... & Hemmer, W. (2012). Reoperations on the pulmonary autograft and pulmonary homograft after the Ross procedure: An update on the German Dutch Ross Registry. *The Journal of thoracic and cardiovascular surgery*, 144(4), 813-823.
19. Takkenberg, J. J. M., Dossche, K. M. E., Hazekamp, M. G., Nijveld, A., Jansen, E. W. L., Waterbolk, T. W., ... & Dutch Ross Study Group. (2002). Report of the Dutch experience with the Ross procedure in 343 patients. *European journal of cardio-thoracic surgery*, 22(1), 70-77.
20. Takkenberg, J. J., Klieverik, L. M., Schoof, P. H., van Suylen, R. J., van Herwerden, L. A., Zondervan, P. E., ... & Bogers, A. J. (2009). The Ross procedure: a systematic review and meta-analysis. *Circulation*, 119(2), 222-228.
21. Mazine A, Rocha RV, El-Hamamsy I, et al. Ross Procedure vs Mechanical Aortic Valve Replacement in Adults: A Systematic Review and Meta-analysis. *JAMA Cardiol.* 2018;3(10):978-987. doi:10.1001/jamacardio.2018.2946
22. Ahmed, A., Ahmed, S., Varghese, K. S., Mathew, D. M., Pandey, R., Rogando, D. O., ... & Levy, K. H. (2021). Decellularized versus cryopreserved pulmonary allografts for right ventricular outflow tract reconstruction during the Ross procedure: a meta-analysis of short-and long-term outcomes. *The Egyptian Heart Journal*, 73, 1-8.
23. Brancaccio, G., Polito, A., Hoxha, S., Gandolfo, F., Giannico, S., Amodeo, A., & Carotti, A. (2014). The Ross procedure in patients aged less than 18 years: the midterm results. *The Journal of thoracic and cardiovascular surgery*, 147(1), 383-388.
24. Tierney, E. S. S., Gersony, W. M., Altmann, K., Solowiejczyk, D. E., Bevilacqua, L. M., Khan, C., ... & Apfel, H. D. (2005). Pulmonary position cryopreserved homografts: durability in pediatric Ross and non-Ross patients. *The Journal of thoracic and cardiovascular surgery*, 130(2), 282-286.
25. Kadner, A., Raisky, O., Degandt, A., Tamisier, D., Bonnet, D., Sidi, D., & Vouhé, P. R. (2008). The Ross procedure in infants and young children. *The Annals of thoracic surgery*, 85(3), 803-808.
26. Pasquali, S. K., Shera, D., Wernovsky, G., Cohen, M. S., Tabbutt, S., Nicolson, S., ... & Marino, B. S. (2007). Midterm outcomes and predictors of reintervention after the Ross procedure in infants, children, and young adults. *The Journal of thoracic and cardiovascular surgery*, 133(4), 893-899.
27. Starnes, V. A., Elsayed, R. S., Cohen, R. G., Olds, A. P., Bojko, M. M., Mack, W. J., ... & Bowdish, M. E. (2023). Long-term outcomes with the pulmonary autograft inclusion technique in adults with bicuspid aortic valves undergoing the Ross procedure. *The Journal of Thoracic and Cardiovascular Surgery*, 165(1), 43-52.
28. El-Hamamsy, I., Toyoda, N., Itagaki, S., Stelzer, P., Varghese, R., Williams, E. E., ... & Adams, D. H. (2022). Propensity-matched comparison of the Ross procedure and prosthetic aortic valve replacement in adults. *Journal of the American College of Cardiology*, 79(8), 805-815.
29. HeartValveSurgery.Com. (2022, November 17). Surgeon Q&A: Ross procedure reoperations with Dr. Michael Ibrahim. YouTube. Retrieved April 21, 2023, from <https://www.youtube.com/watch?v=WpwZN61Rh80>
30. The Ross procedure: Advantages for select patients with aortic valve disease. Heart Valve Surgery. (n.d.). Retrieved April 21, 2023, from <https://www.heart-valve-surgery.com/videos/ross-procedure-aortic-valve-dr-peter-skillington.php>