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AORTIC VALVE REPLACEMENT WITH HOMOGRAFT AND AUTOGRAFT VALVES
Performance of 615 Valves Over 15 Years

W. H. Wain, R. Greco, E. Bodnar and D. N. Ross

National Heart Hospital and Cardiothoracic Institute. London, W1. England.

Homograft valve replacement of the diseased aortic valve with a homologous aortic valve inserted in the sub-coronary position was first performed in July 1962 (Ross 1962). The procedure of transferring the patients autologous pulmonary valve to the aortic position has been used since 1967 (Ross 1967).

The long term performance of homograft valves has not been regarded as satisfactory in some centres (Copeland 1977, Anderson and Hancock 1977) whereas others have shown it to be an excellent valve replacement (Barratt-Boyes 1977; Bodnar et al 1979).

The differing experiences may be the results of alternative methods of sterilization, preservation and surgical insertion. This paper presents information on isolated aortic valve replacements with either homograft or autograft valves over a 15 year period.

MATERIALS AND METHODS

Six hundred and fifteen valves have been followed for up to 15 years, and there were 145 freeze dried homografts, 89 frozen homografts, 202 fresh homografts and 179 pulmonary autografts (Table 1). The details of the different sterilization and preservation methods and surgical techniques have been outlined (Ross et al 1979; Bodnar et al 1979). This paper presents information on valve performance gathered from patient records, from routine Out-Patient Clinics, doctor's letters, re-operations and post-mortem reports.

Table 1

Aortic Valve Replacements with Homograft and Autograft Valves

Preservation	Period	Number
Freeze Dried Homografts	1964-1967	145
Frozen Homografts	1968-1970	89
Fresh Homografts	1971-1979	202
Autografts	1967-1979	179
Total		615

In order to assess valve performance, several possible malfunctions of the valve have been considered (Bodnar et al 1979). Patients who were alive at the time of this follow-up study, or whose death has not been accompanied by or caused by any of these malfunctions have valves described as *free* of *valve-related death* or *fatal malfunctions*. Similarly, those patients who are alive and who have never experienced any of these complications have valves descrived as *complication-free*. The individual complications have been analysed as *infective valvular* endocarditis; as *degeneration* of the valve tissue with histological evidence of degeneration; as *technical error* associated with mal-insertion; and as *thromboembolism*.

Actuarial Methods

Life tables have been constructed according to Greenwood (1926) and the *valve-related death* and *complication-free* survival curves have been constructed following the method of Grunkemier et al (1975). Individual complications, such as infective endocarditis, have been analysed according to Anderson et al (1974). A comprehensive account of all these actuarial methods is detailed by Bodnar, Habermann and Wain (1979).

RESULTS

Valve Related Deaths

There have been 41 valve related late deaths amongst the 615 valves, an incidence of 6.7%. These include the operative mortality consequent upon re-operation to replace malfunctioning valves. These valve related deaths have been classified according to the type of valve failure as well as the method of valve preparation (Table 2). Actuarial analyses for these valve related deaths related to the four methods of valve preparation are shown in Fig. 1. There is no significant difference between the autograft valves and the frozen and fresh homograft valves.

Table 2

Aortic Valve Replacement with Homograft and Autograft Valves
Causes of Late Mortality

	Freeze Dried (145)	Frozen (89)	Fresh (202)	Autografts (179)	Total (615)
Technical	8	2	0	1	11
Infective	6	1	4	3	14
Degeneration	11	2	1	2	15
Total	25	5	5	6	41 (6.6%)

Thromboembolism

There was only one case of a transient unilateral blindness 3 years after the insertion of the valve. This represents an incidence amongst the 615 valves over a 15 year period of 1 per 2314 patient-years.

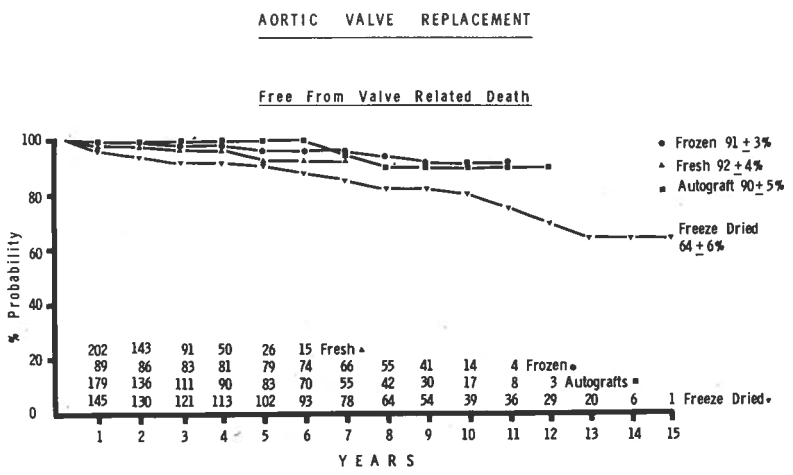

Fig. 1 — *Probability of freedom valve-related death. Freeze dried, frozen and fresh homograft and autograft aortic valve replacements have been analysed separately. Only those deaths which could be specifically associated with a valve malfunction have been included.*

Technical Error

Valve complications associated with poor valve preparation or technical malinsertion usually required surgical intervention within three years. Actuarial analysis of such valve failures (Fig. 2) has shown a greater probability for the freeze dried homograft values (13% at 14 years) but a factor possibly associated with this was the problem of developing the surgical techniques in the period 1964-1967.

The fresh homograft valves were introduced at the same time (1970) as a modification of the surgical techniques in which the lower suture line was inserted with a continuous running suture. This may account for the 10% of technical failures with fresh homografts over 7 years, a significantly higher value than that of the autograft valves or frozen homograft valves.

Infective Endocarditis

Infection on the valve was rare and was distributed throughout the follow-up period indicating that there was a satisfactory sterilization process (Fig. 3). There is a tendency for a slight increase in infection during the second 5 years of follow-up.

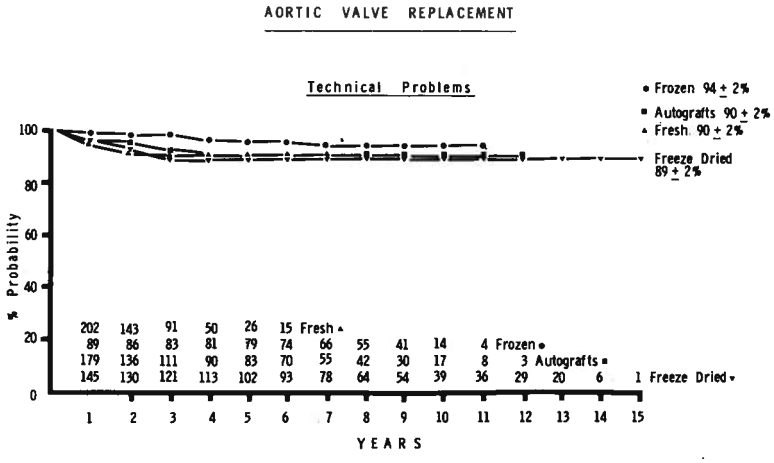

Fig. 2 — *Probability of freedom from technical problems, Freeze dried, frozen and fresh homograft and autograft aortic valve replacements have been analysed separately. Valve related deaths not associated with technical problems have been excluded.*

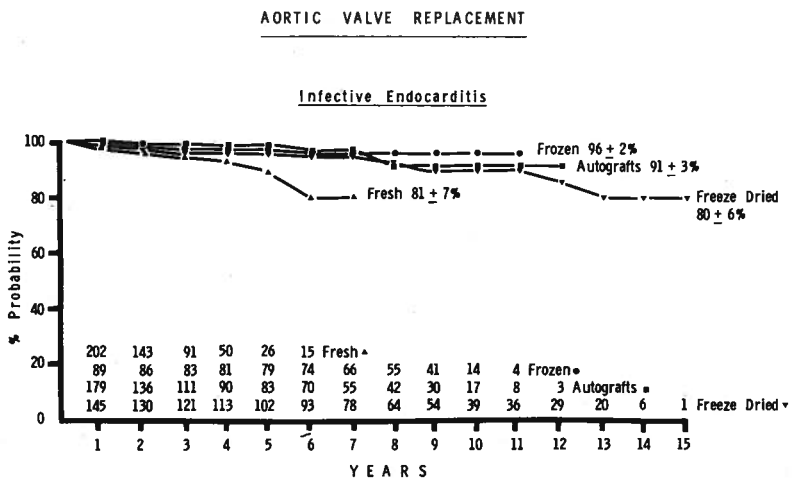

Fig. 3 — *Probability of freedom from infective endocarditis Freeze dried, frozen and fresh homograft and autograft artic valve replacements have been analysed separately. Valve related deaths not due to infective endocarditis have been excluded.*

Degeneration

The onset of this process after 3 to 5 years may be preceded by a higher susceptibility to infection (Fig. 3 of Fig. 4) or may be a consequence of undetected infections or may be unrelated.

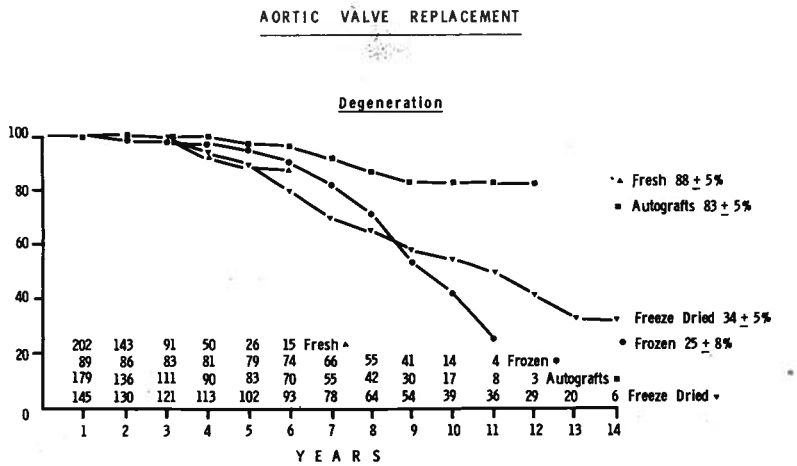

Fig. 4 — *Probability of freedom from degeneration. Freeze dried, frozen and fresh homograft and autograft aortic valve replacements have been analysed separately. Valve related deaths not due to degenerative valve failure failure have been excluded.*

It is clear from Fig. 4 that degenerative processs become important during the second half of the decade. This is a continuing trend and it is anticipated that few homograft valves will continue to function for 20 years. However, the autograft valves in Fig. 4 show a much slower level of degeneration and it is hoped that they will prove to be potentially permanent valve replacements. It should be emphasised however that even at 10 years, 54% of freeze dried homograft valves were still free of degeneration.

A summary of Figs. 1to 4 is presented in Fig. 5 as a cumulative presentation of valves free from complications which is greatly influenced by the degeneration of valves in Fig. 4. The superiority of the autograft valves is still apparent and has been emphasised in Fig. 6, in which all the homograft valves have been grouped together.

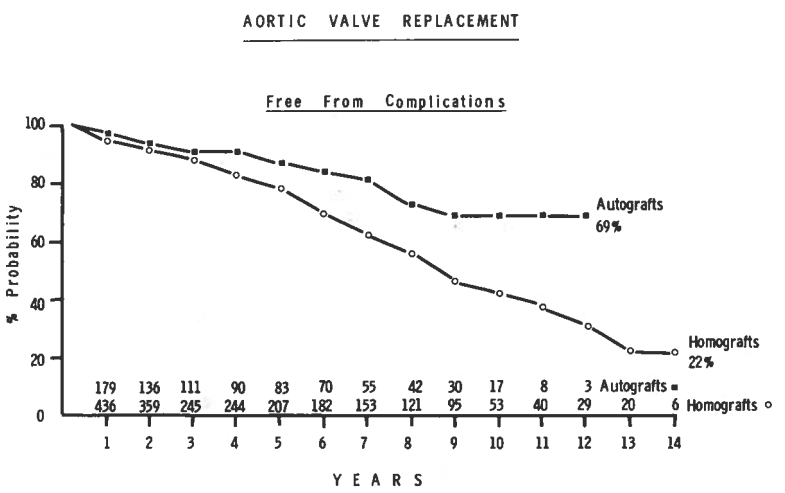

Fig. 5 — *Probability of freedom from cumulative complication Freeze dried, frozen and fresh homograft and autograft aortic valve replacements have been analysed separately. All valve malfunctions including all valve-related deaths have been accumulated for this analysis.*

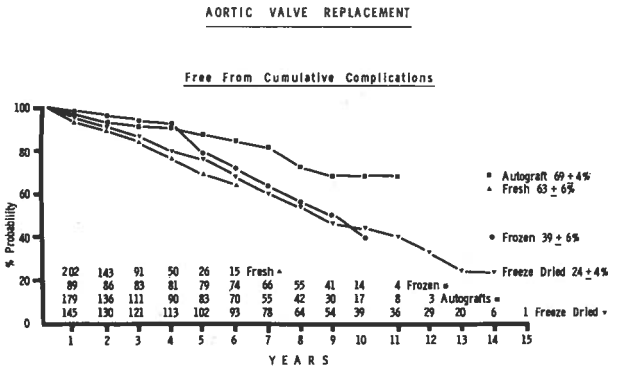

Fig. 6 — *Probability of freedom from complications. Homograft and autograft aortic valve replacements have been analysed separately. All complications, fatal and non-fatal, have been included in this analysis.*

DISCUSSION

This study has separated valve performance from patient survival in an attempt to reduce bias from assumptions about long-term performance of these valves. The incidence of valve related deaths over this 15 year follow-up period is small when compared with the natural history of isolated aortic valve disease in a non-surgically treated patient. (Ross and Braunwald 1968). Comparisons with published results on other valves are difficult but some studies indicate a clear superiority of the homograft valve (Ross et al 1979; Bodnar et al 1979). The very low rate of thromboembolism when compared to prosthetic valves (McHenry et al 1978; Blackstone et al 1977) highlights the special problems of prosthetic valves in which thromboembolism is a recurrent problem which may cause permanent damage or death. Many of the complications associated with homograft and autograft valves are slow in onset and can be reoperated as elective surgical procedures which have beneficial results rather than permanent sequelae. The cumulative complications presented in Figs. 5 and 6 demonstrate a clear superiority of the autograft valve but also indicate that 42% of the homograft valves will enter their second decade free of any complication.

RESUMO

SUBSTITUIÇÃO DA VÁLVULA AÓRTICA COM HOMO E AUTOENXERTOS

É analisado o comportamento, por um período de mais de 15 anos, de 6/5 homoenxertos e autoenxertos em posição aórtica. A incidência de morte relacionada com o enxerto foi de 6,7%. A frequência de tromboembolismo foi de 1 por 2314 doentes-anos. A insuficiência valvular foi mais frequente no caso de homoenxertos «freeze-dried».

A endocardite infecciosa foi rara. Pensa-se que poucos homoenxertos continuarão a funcionar bem 2ó anos após a implantação, mas 42% entrarão na 2.ª década de existência sem terem tido complicações. Os autoenxertos revelaram uma incidência muito menor de degenerescência. Muitas das complicações associadas com os homo e autoenxertos aparecem gradualmente uma reintervenção electiva.

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Adress for reprints: *William H. Wain*
2 Beaumont Street
London W1N
England