Aortic Root Replacement With Biological Valved Conduits

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The execution of Bentall procedures using biological valved conduits is expanding owing to the increased incidence of aortic valve and root diseases in the aging population. To review the available data, a systematic search identified 29 studies with a total of 3,298 patients. Although evidence on short-term results suggested favorable outcomes after biological Bentall operations, data beyond 5 years are limited and highlight the urgent need for further investigations with longer follow-up.

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In 1968, Bentall and DeBono [1] first described the technique for complete replacement of the ascending aorta and aortic valve with the reimplantation of the coronary arteries. Since its introduction, this technique, which subsequently became known as the Bentall operation, has been considered the gold standard in the surgical treatment of combined aortic valve and ascending aorta diseases.

The increasing age of patients currently requiring aortic root surgery and excellent long-term durability of newer biological aortic valve prostheses have stimulated an increase in the use of biological valved conduits, such as biological hand-sewn composite grafts, total biological root prostheses, and allografts. Despite this, data on biological Bentall procedures are sparse.

The present systematic review aimed to evaluate early and late clinical outcomes after Bentall operations using biological valved conduits.

Material and Methods

Literature Search Strategy

Electronic searches were performed using PubMed, from the date of inception to February 2014. To achieve the maximum sensitivity of the search strategy and identify all studies, we combined the following terms: "aortic diseases/surgery" [Mesh] AND Bentall [Title] OR stented bioprosthetic valved conduit [Title] OR biological [Title] OR root bioprosthesis [Title] OR biological valved conduit [Title] OR biological root [Title] OR composite graft [Title] AND English [Language]." The reference lists of all retrieved articles were reviewed for further identification of potentially relevant studies. All identified articles were systematically assessed using the inclusion and exclusion criteria.

Selection Criteria

Eligible studies for the present systematic review included those in which patient cohorts underwent Bentall procedures with biological prostheses. Primary end points included in-hospital (or 30 days) mortality, stroke, renal failure, respiratory failure, myocardial infarction, as well as follow-up survival, freedom from aortic reintervention, freedom from thromboembolic events, and freedom from prosthesis endocarditis. Studies that did not include predetermined primary or secondary end points were excluded. When institutions published duplicate studies with accumulating numbers of patients or increased lengths of follow-up, only the most complete reports were included for quantitative assessment at each time interval. All publications were limited to those involving human subjects and reported in the English language. Abstracts, case reports, conference presentations, editorials, and expert opinions were excluded. Review articles were omitted because of potential publication bias and duplication of results.

Data Extraction and Critical Appraisal

All data were extracted from article texts, tables, and figures and subsequently tabulated by three of the investigators (S.C., G.M., M.C.). Data were reviewed by another investigator (D.H.T.). Discrepancies between the reviewers were resolved by discussion and consensus. The final results were reviewed by the senior investigator (M.D.E.). The quality of studies was assessed using criteria recommended by the National Health Service Centre for Reviews and Dissemination case series quality assessment criteria (University of York, UK) [2].

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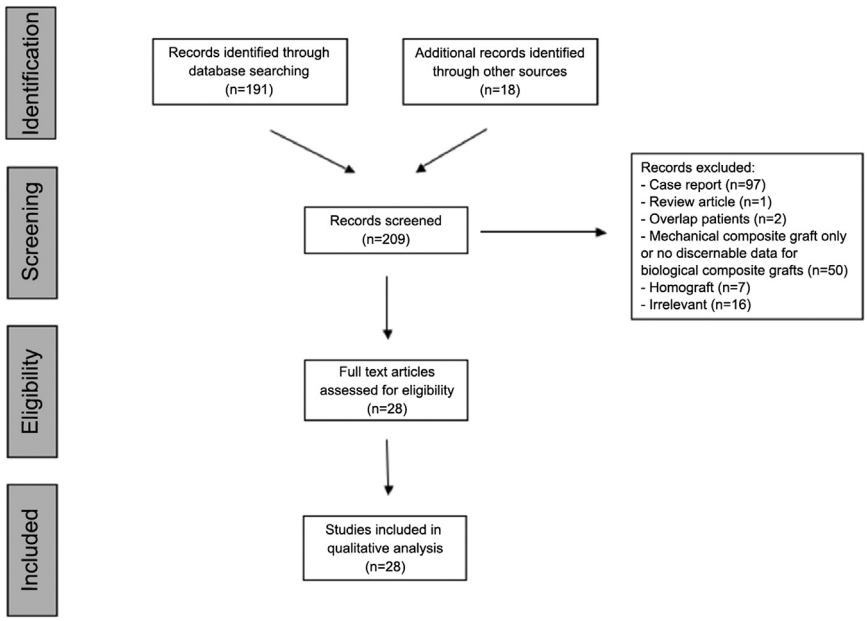

Fig 1. Search strategy of systematic review on Bentall operation using biological valved conduit. From Moher D, Liberati A, Tetzlaff J, Altman DG. The PRISMA flow-chart [8].

Statistical Analysis

Standard descriptive statistics were used to summarize demographic and baseline data of eligible patients. Data were presented as N (%) or mean ± standard deviation as appropriate. Pooled averages were estimated using the random-effects model as proposed by DerSimonian and Laird [3]. Pooled values were calculated when results were reported by at least 50% of studies and at least 50% of patients. The method of Hozo and colleagues [4] was used to estimate the mean and variance in studies that only reported median and range. Individual patient survival data were reconstructed using an iterative algorithm that was applied to solve the Kaplan-Meier equations originally used to produce the published graphs. This algorithm, as provided by Guyot and colleagues [5], uses digitalized Kaplan-Meier curve data to find numerical solutions to the inverted Kaplan-Meier equations. This algorithm assumed constant censoring (ie, that the censoring mechanism was noninformative), and was implemented in R (v.3.1.0). The reconstructed patient survival data for each study were then aggregated to form combined survival curves. Mixed effects meta-regression was conducted against outcomes on study-level variables. Evidence of publication bias was sought using the methods of Egger and associates [6] and Begg and Mazumdar [7]. If studies appear to be missing in areas of low statistical significance, then it is possible that the asymmetry is a result of publication bias. If studies appear to be missing in areas of high statistical significance, then publication bias is a less likely cause of funnel asymmetry. Intercept significance was determined by the Student's *t* test suggested by Egger and associates [6]. All statistical analyses were conducted with Comprehensive Meta-analysis v2.2 (Biostat Inc, Englewood, NJ) or Stata version 11.0 (Stata Corp, College Station, TX).

Results

Quantity of Studies

A total of 209 studies were identified through PubMed database and other sources. After exclusion of duplicate or irrelevant references, 28 studies remained for assessment. The study selection process is presented in Figure 1 according to the PRISMA statement [8]. One study was separated into two studies because it reported data on two different bioprostheses [9]. A total of 29 series were therefore assessed [9–36]. All of the included studies were retrospective observational studies except one prospective series [16]. Fourteen studies had more than 100 patients (range, 101 to 317 patients) [10, 11, 13, 18, 21, 22, 24, 25, 27, 29, 31, 32, 34, 35], including two multicenter registries [10, 32], and the remaining series had fewer than 100 patients (range, 10 to 80 patients) [9, 12, 14–17, 19, 20, 23, 26, 28, 30, 33, 36].

Fourteen studies reported follow-up greater than 36 months (range, 37 to 92 months) [10, 12, 16, 18, 21, 22, 24, 25, 27, 30, 31, 33–35]. Five studies had follow-up less than 3 years (range, 6 to 24 months) [14, 20, 23, 28, 36], and the remaining studies did not report length of follow-up [9, 11, 13, 17, 19, 26, 29, 32]. The study characteristics are summarized in Table 1. In these 29 series, 3,298 patients underwent the Bentall procedure with a biological prosthesis.

Demographic Data

Overall, 67.5% of patients were male, with a weighted mean age of 67.1 years. Degenerative aneurysm was the sole surgical indication in one study [20], whereas the rest included a combination of aneurysm, acute aortic dissection, and aortic valve endocarditis. Overall, however, degenerative aneurysm was the primary indication