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The valve-sparing aortic root replacement: Results of the David I technique

The aim – to determine the long-term results and quality of life of patients who underwent David I valve-sparing operation.

Materials and methods. The one-center study included 53 patients who underwent planned and urgent David I procedure (valve-sparing replacement of the aortic root and ascending aorta) from 2015 to 2023. The mean age of the 53 patients (among them, 47 (88.68 %) males) was 49.11 ± 1.54 years. We analyzed basic characteristics of the patients, intraoperative and postoperative data. The quality of life was assessed before and in the long-term period after operations by the Medical Outcomes Study Short Form 36 (MOS SF-36) questionnaire.

Results and discussion. An average duration of the follow-up period was 2.59 ± 0.27 years ranging from 1.0 to 9.0 years. Overall in-hospital mortality and 30-day mortality was 1.89 % (n 1). Estimated 5-year survival rate was 95.7 ± 1.45 % for all patients. The average duration of the operations was 291.23 ± 12.67 minutes, the total duration of artificial blood circulation was 170.28 ± 8.77 minutes, aorta clamping time – 122.02 ± 5.92 minutes. The mean duration of stay in the hospital was 13.81 ± 0.54 days, intensive care unit – 2.94 ± 0.03 days. The number of patients extubated up to 8 hours after surgery was 48 patients (90.57 %). The performed operation significantly improved the indicators. Patients positively perceived the information about the absence of an artificial heart valve and need of concomitant use of anticoagulants. The patients had a good psycho-social component, which probably affected the assessment of other scales.

Conclusions. Patients after David I operation have a low overall in-hospital mortality and 30-day mortality, with a short period of time in intensive care unit and hospital at all. Long-term results in indicator of 5-year survival are excellent. The operation significantly improves quality of life parameters.

Key words: quality of life, David operation, aortic valve, ascending aorta, aortic root aneurysm.

A lot of years surgeons perform Bentall operation in cases of aortic root aneurysm. It was known as a standard technique of treating this type of patients [1–3].

Tirone David was the first, who performed valve-sparing surgery of the root and ascending part of the aorta in 1889. He divided valve-sparing operations into two main types: reimplantation and remodeling technique. Nowadays surgeons do hundreds of these interventions every year

all over the world. It is an operation of choice in patients with aortic root aneurysm with minimal changes of aortic cusps [2–5].

The trend of growing interest in the study of quality of life increases every year [6, 7]. The concept of quality of life is widely used in medicine and is an integral indicator that reflects a person's adaptation to the disease and his ability to perform usual functions. The study of quality of life among patients undergoing cardiac surgery

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Table 1
Baseline characteristics of the patients

Indicator		Patients (n = 53)
Sex	Male	47 (88.68)
	Female	6 (11.32)
Age, years		49.11 ± 1.54
Height, cm		180.83 ± 1.18
Weight, kg		87.58 ± 2.23
Body mass index kg/m ²		26.81 ± 0.65
Bicuspid aortic valve		9 (16.98)
Tricuspid aortic valve		44 (83.02)
End diastolic volume index, ml/m ²		94.00 ± 5.26
Left ventricular ejection fraction, %		58.34 ± 1.16
Ascending aorta, mm		46.02 ± 2.31
Aortic root, mm		46.09 ± 2.24
Pulmonary hypertension		20 (37.74)
Smoking		11 (20.75)
Myocardial infarction in the past		1 (1.89)
History of cerebrovascular events		2 (3.77)
Previous interventions on the heart (stenting and open operations)		3 (5.66)
Diabetes		1 (1.89)

on aorta remains a less studied issue. We need to show the indicators of quality of life after valve-sparing operations in long-term period [7–10].

We use reimplantation technique during the past 9 years. This article will show our clinical experience and quality of life of the patients who underwent valve-sparing David I operation.

The aim – to determine the long-term results and quality of life of patients who underwent David I valve-sparing operation.

Materials and methods

A review of the Cardiac Surgery Database of the Heart Institute of the Ministry of Health of Ukraine revealed 53 patients who underwent David I operation from 2015 to 2023. This study examined the clinical outcomes of patients who had reimplantation of the aortic valve. The Research Ethics Board of the Heart Institute of the Ministry of Health of Ukraine allowed this retrospective research. All baseline clinical data are showed in *Table 1*.

Operative Technique

After selective pumping of cardioplegic cold crystalloid solution «Kustodiol», excision of the

aneurysmal part of the ascending aorta and the root in the area of the sinuses was performed. Excision of the buttons of the coronary arteries was carried out and they were taken on tripods. Aortic valve leaflets were evaluated. After measuring of the height of the aortic valve commissures, appropriate markings were made on the vascular dacron tubular prosthesis (Maquet). 9 stitches were applied – 3 on the tops of the commissures and the base of the commissures, 3 stitches with Prolene 4.0 in the middle of the sinuses. After sewing 9 stitches through the vascular prosthesis, it was implanted. The prosthesis was stitched from the inside with three sutures placed in the middle of the sinuses. Reimplantation of the buttons of the coronary arteries was carried out. In patients where there was a need for a complete stoppage of blood circulation, parallel cerebral perfusion was maintained (10 % of the work of the artificial blood circulation). A distal anastomosis was formed. Finally, heart rhythm was restored and wound closure was performed.

Quality of life

Quality of life was assessed before surgery and in the long-term period after surgery using

the Medical Outcomes Study Short Form 36 (MOS SF-36) questionnaire. The survey was conducted after the informed consent of the patient to participate in the study. The rules for filling out the questionnaires were explained to the patients. Then, within 10–15 minutes, the patients filled out the Ukrainian version of the SF-36 questionnaire on their own. Results were calculated without the presence of the patients.

The questionnaire included 36 items, which are grouped in 8 scales: physical functioning (PF), role limitations due to physical health (RP), body pain (BP), general health (GH), vitality (VT), social functioning (SF), role limitations due to emotional problems (RE) and mental health (MH). The patient chose the answer to the proposed question [7–9].

Due to the normal distribution, statistical data are presented as mean and standard deviation. Mean values were compared using Student's t-test. The difference at $p < 0.05$ was considered as statistically significant.

Results and discussion

An average duration of the follow-up period was 2.59 ± 0.27 years ranging from 1.0 to 9.0 years. Overall in-hospital mortality and 30-day mortality was 1.89 % ($n = 1$). Estimated 5-year survival rate was 95.7 ± 1.45 % for all patients.

According to the duration of operations, the average duration of the operations was 291.23 ± 12.67 minutes, the total duration of artificial blood circulation was 170.28 ± 8.77 minutes, aorta clamping time – 122.02 ± 5.92 minutes (Table 2).

Complete circulatory arrest with hypothermia up to 22°C with parallel cerebral perfusion was observed. This was necessary in some patients to form a distal anastomosis. This proportion was 6 (11.32 %) patients with a duration of 11.83 ± 1.62 min (Table 2).

The average duration of hospital staying was 13.81 ± 0.54 days, intensive care unit – 2.94 ± 0.03 days. The number of patients extubated up to 8 hours after surgery was 48 patients (90.57 %) (Table 2).

We performed also concomitant operations with David I procedure: CABG in 7 patients (13.21), mitral valve repair in 7 patients (13.21), CABG with mitral valve repair in 1 patient (1.89) (Table 3).

We analyzed quality of life before and after operation. The lowest indicators of physical functioning, vital energy, and emotional func-

Table 2
Perioperative characteristics and stay in the intensive care unit

Indicator	Patients (n = 53)
Total operation duration, min	291.23 ± 12.67
Total duration of artificial blood circulation, min	170.28 ± 8.77
Aortic clamping time, min	122.02 ± 5.92
Average minimum temperature, $^\circ\text{C}$	30.12 ± 0.37
Complete stoppage of circulation	6 (11.32)
Duration of complete circulatory arrest, min	11.83 ± 1.62
Number of patients extubated up to 8 hours after surgery	48 (90.57)
Duration of staying in intensive care unit, days	2.94 ± 0.03
Duration of staying in hospital, days	13.81 ± 0.54

Table 3
Concomitant operations

Concomitant operation	Patients (n = 53)
CABG	7 (13.21)
Mitral valve repair	7 (13.21)
CABG with mitral valve repair	1 (1.89)

tioning were obtained during the further study of the values of quality of life indicators. The presence of pathology caused complaints such as bad health, rapid fatigue, and fear of pain. These complaints were an obstacle to a well-balanced life (Table 4).

The performed operation significantly improved the indicators. Patients positively perceived the information about the absence of an artificial heart valve and need of concomitant use of anticoagulants (Table 4).

We noticed during the assessment, that the patients had a good psycho-social component, which probably affected the assessment of other scales.

Our report indicates that early and long-term results of David technique are excellent, and operations provide a safe surgical option for patients with aortic root disease. Our team performed different types of aortic valve preserving operations during the past 9 years.

Table 4
Quality of life before and in long-term period after operations

Scale	Before operation	After operation	p
Physical functioning, PF	32.69 ± 0.63	95.38 ± 6.62	0.000
Role limitations due to physical health, RF	45.26 ± 1.20	94.10 ± 1.55	0.000
Role limitations due to emotional problems, RE	43.21 ± 0.79	99.74 ± 0.26	0.000
Vitality, VT	31.79 ± 0.39	91.92 ± 1.44	0.000
Mental health, MH	32.69 ± 0.63	98.67 ± 0.49	0.000
Social functioning, SF	54.36 ± 0.74	99.31 ± 0.41	0.000
Body pain, BP	62.31 ± 0.68	94.74 ± 1.15	0.000
General health, GH	36.03 ± 0.59	91.18 ± 1.62	0.000

Such valve-preserving operations as remodeling (Yacoub) and reimplantation (David) were evaluated as alternatives. The main advantage was the absence of long-term anticoagulation. Some authors described erosion due to supposed leaflet contact with the straight Dacron graft in 'David I' procedure. We did not observe this effect in our series of patients. So, the original reimplantation procedure using a straight graft does not seem to have a negative impact on the leaflets [11–14].

We had cases with one and two or three dilated sinuses. In case of one dilated sinus we prefer to do it with a graft that is tailored to recreate the sinus. In cases of three dilated sinuses we prefer reimplantation technique (David I). The long-term survival is excellent in our experience. We didn't observe any cases of moderate or severe aortic insufficiency in patients operated on during the follow-up period.

Cardiac surgery carries different risks and causes emotional disorders. Low mood, anxiety, depression, and fear are combined with physical and mental health disorders. Speaking about preoperative quality of life, patients described all indicators as low. They had such complaints like shortness of breath, pain behind the sternum, dizziness, which prevented normal physical activity. Only the thought of the presence of such a pathology prevented normal communication and lowered the emotional state.

The surgical intervention improved all parameters. Already after being transferred from the intensive care unit, the patients felt a clear improvement, which was manifested in positive emotions, a desire for communication, and minor physical activity.

The problem of comparing Bentall procedure with mechanical prosthesis and David procedure is not solved nowadays. We will compare operative data, postoperative period, quality of life and long-term results in our future studies.

To our mind, valve sparing aortic root replacement is an effective type of treatment in patients with aortic root aneurysm and normal cusps. In highly specialized centers it provides excellent long-term results.

Conclusions

Patients after David I operation have a low overall in-hospital mortality and 30-day mortality, with a short period of time in intensive care unit and hospital at all. Long-term results in indicator of 5-year survival are excellent. The operation significantly improves quality of life parameters.

Prospects for future research

We need to compare preoperative, intraoperative, early postoperative period, long term results and quality of life in patients after Bentall procedure and David I procedure.

Compliance with ethical requirements

The present study was conducted in accordance with the basic principles of the European Convention of Human Rights and Biomedicine, World Medical Association Declaration of Helsinki on the ethical principles for medical research involving human subjects and current Ukrainian regulations. The study protocol was approved by the local ethics committee. The written informed consent was obtained from all the patients.

Funding and conflict of interest

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Клапанозбережне протезування кореня аорти: результати операції Девіда І

Мета роботи – визначити віддалені результати та якість життя пацієнтів, яким виконано клапанозбережну операцію Девіда І.

Матеріали і методи. В одноцентровому дослідженні обстежено 53 хворих (серед них 47 (88,68 %) чоловіків), які перенесли планове та невідкладне оперативне лікування – операцію Девіда І (клапанозбережне протезування кореня аорти та висхідної аорти), з 2015 до 2023 року. Середній вік пацієнтів становив (49,11 ± 1,54) року. Проаналізовано основні характеристики хворих, інтраопераційні та післяопераційні дані. Якість життя оцінювали до оперативного втручання та у віддалений період після операції за допомогою опитувальника Medical Outcomes Study Short Form 36 (MOS SF-36).

Результати та обговорення. Середня тривалість періоду спостереження становила $(2,59 \pm 0,27)$ року в діапазоні від 1 до 9 років. Загальна внутрішньолікарняна та 30-денна смертність становила 1,89 % ($n = 1$). Розрахункова 5-річна виживаність становила $(95,7 \pm 1,45)$ % для всіх пацієнтів. Середня тривалість операцій становила $(291,23 \pm 12,67)$ хв, загальна тривалість штучного кровообігу – $(170,28 \pm 8,77)$ хв, час перетискання аорти – $(122,02 \pm 5,92)$ хв. Середня тривалість перебування в стаціонарі становила $(13,81 \pm 0,54)$ доби, у відділенні інтенсивної терапії – $(2,94 \pm 0,03)$ доби. Пацієнтів, екстубованих до 8 годин після операції, було 48 (90,57 %). Проведена операція значно поліпшила показники. Пацієнти позитивно сприйняли інформацію про відсутність штучного клапана серця та відсутність необхідності одночасного прийому антикоагулянтів. Під час оцінювання ми помітили, що пацієнти мали хороший психосоціальний компонент, і це, ймовірно, вплинуло на оцінку інших шкал.

Висновки. Пацієнти після операції Девіда I мають низьку загальну внутрішньолікарняну смертність і 30-денну смертність, з коротким терміном перебування у відділенні інтенсивної терапії та лікарні загалом. Віддалені результати за показником 5-річного виживання відмінні. Операція істотно змінює якість життя пацієнтів.

Ключові слова: якість життя, операція Девіда, аортальний клапан, висхідна аорта, аневризма кореня аорти.