Surgical Treatment of Thoracic Aorta Aneurysms: The Modified Inclusion Technique (*)

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Different surgical techniques like cardio-pulmonary bypass or various shunts can be used in the treatment of thoracic aorta aneurysms. Another safe and effective technique is the inclusion method. In the inclusion technique, cross-clamps are placed proximal and distal to the aneurysm and interposition by synthetic graft is performed. The superiority of this technique is accepted by many surgeons. The mortality and the morbidity of the surgical treatment of thoracic aorta aneurysms in experienced centers is around 0%. We modified this method by using double cross-clamps instead single and transecting the aorta between each double clamps. This approach greatly facilitated exposure and provided a clean operative area with great ease and safety.

Eight thoracic aorta aneurysms were treated surgically with this modified inclusion technique, in other words ***"double cross clamps method"*** *between January 1985 and January 1989. The mean age was 48, (youngest: 33, oldest: 65), three of the patients were female and the rest male. During the procedure, double aortic cross-clamps were used. The mean cross-clamp time was 23 minutes. In one case recurrent nerve paralysis occured. There was no death.*

In this article, the surgical details of the modification of the inclusion technique by using double cross clamps has been given, and the preliminary clinical results have been reported and the advantages of this new method in the meaning of clinical results, operation time, cross-clamp time, surgical exposure and blood preservation have been discussed.

In conclusion we think that the "double cross-clamps method" is the most effective and the safest surgical technique in the treatment of thoracic aorta aneurysms.

Up to the present time, various techniques for the surgical treatment of descending aorta aneurysms have been tried. These are: 1. Bypass techniques, 2. Shunt techniques, 3. Inclusion techniques.

Among these, bypass and shunt techniques are more

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complicated and difficult in terms of surgical technique, require highly qualified personnel, take longer operating time, and can only be performed in open heart surgery units. The mortality and morbidity rates are higher for these techniques[1,2]. However, the inclusion technique is the most economical and beneficial with regard to equipment, time, and personnel.

Surgical preperation time for the inclusion technique is very short, where as surgical intervention with the bypass or shunt techniques take considerable time which may be the cause of death[8,9,18,23].

But, in inclusion technique (Fig. 1), after planning the cross clamps proximal and distal to the aneurysm, aneurysmal sac have to be incised, blood and necrotic material aspirated, cleaned, and hemostasis has to be completed. These maneuvers cause the cross-clamp time to be longer. To overcome these handicaps and to shorten further the cross clamp time, we modified the inclusion technique by using double cross clamps proximal and distal to the aneurysm and so, leave the incising the aneurysmal sac, cleaning and aspirating the necrotic material and performing the hemostasis (e.g. ligating the intercostal artery ostia) after completion of the proximal and distal anasthomoses of the synthetic bypass graft.

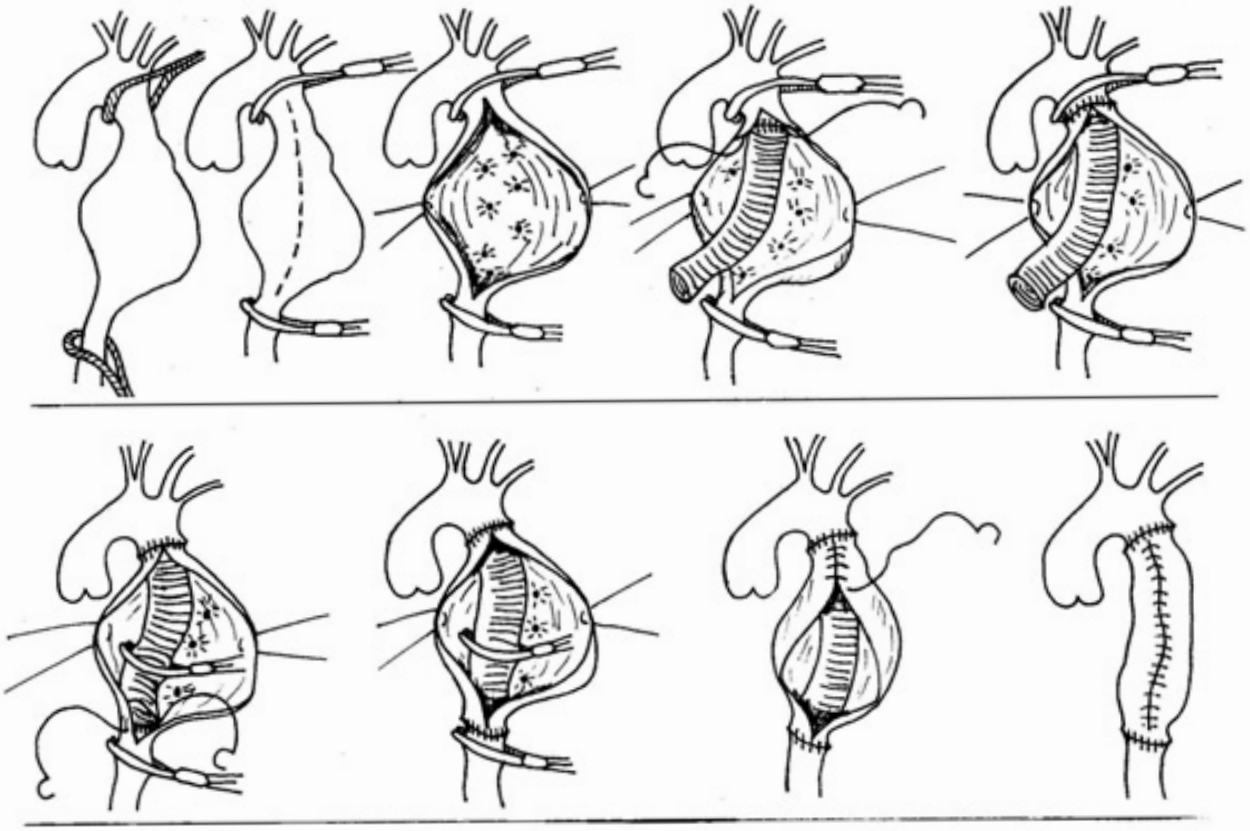

Fig. 1: Schematic presentation of the inclusion technique in 8 consecutive steps.

Material and Methods

Between January, 1985 and January, 1989, 38 patients were operated because of aortic aneurysm. In 8 of these patients the pathology was located at the descending aorta. Double cross-clamps technique has been used to treat these patients. Three of the patients were female and 5 were male, their ages ranged between 33 and 65 with an average of 48 years.

Clinical symptoms and physical findings have been summarized in Tables I and II. Pain, dyspnea, caugh, dysphagia were the most frequent symptoms. The etiology of the aneurysm was arteriosclerosis in all cases.

The cross-clamp time varied between 18 and 36 minutes with an average of 23 minutes.

Surgical Treatment

The details of surgical technique is shown schematically in fig. 2. All of the patients were approached by a posterolateral thoracotomy incision. In four cases which have longer aneurysms the exposure of proximal and distal of the aneurysm could be obtained by two adjacent intercostal spaces. This approach shortened the cross clamp time. A pair of cross clamps were placed proximal to the aneurysm first and the aorta transected between these clamps. A preclotted dacron vowen graft anasthomozed by 3/0 or 4/0 monofilament polypropylene running suture to the proximal aorta. Then, another pair of cross clamps planced distal to the aneurysm and also aorta transected between these two clamps and distal of the graft anasthomosed to the distal aorta by the same method. After the completion of the anasthomoses, and removal of the clamps at the aorta, the clamps at the distal and proximal ends of the aneurysm were removed. Aneurysmal sac incised and opened, blood aspirated by the cell saver device and necrotic material cleaned and hemostasis performed. Then, aneurysmal sac wrapped around the graft.

Arterial hypertension proximal and distal to the clamps was controlled by vasodilators. Blood pressures proximal and distal to the clamps were recorded simultaneously via radial and femoral artery pressure catheters. Table III summarizes the intraoperative findings.

Table I: Clinical Symptoms and Signs of 8 Patients with Descending Aortic Aneurysm:

		%
Pain	8	100
Dyspnea	7	87.5
Caugh	4	50
Dysphagia	2	25
Hemathemesis	1	12.5
Hemoptysis	1	12.5
Dysphonia	2	25
Peripheric Embolism	2	25
Neurologic Deficit	1	12.5

Results

With the use of the double cross-clamps technique, the aortic cross-clamp periods were considerably shorter. The range was 18-36 minutes with an average of 23 minutes. Working in a blood free area is another technical advantage. Bleeding was not a major problem with a range of 730 to 1540 ml. The average drainage was

Table II: Clinical Characteristics and Results of 8 Patients.

Patients: (age/sex)	Morphology	ot / cct (min)	bleeding (ml)
44/E	arcus+thoracic aorta, fusiform	111 / 21	1540
52/E	thoracic aorta, saccular	86 / 18	1090
65/E	thoracic aorta, dissecting	120 / 25	730
33/E	thoracic aorta, fusiform	141 / 23	1045
39/K	" "	120 / 36	1380
52/K	" "	104 / 22	1410
56/E	" "	105 / 19	825
43/K	" "	114 / 23	910
			Mean: 1116

ot= Operation time
cct= Cross-clamp time

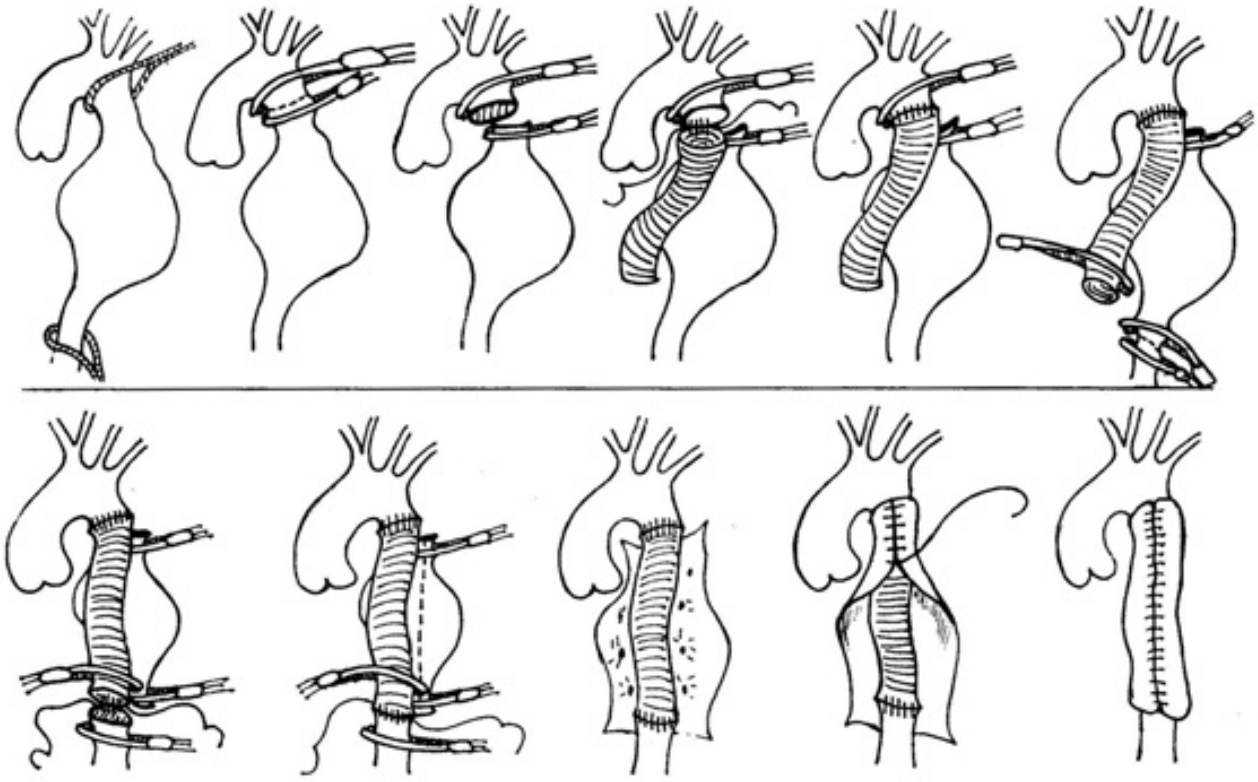

Fig.2: Schematic presentation of the double cross-clamps technique in 10 consecutive steps.

Table III: Intra Operative Characteristics and Results of 8 Patients Operated with DCC Technique:

HR	BP (S/D)		Maximal Proximal	Distal	Duration of controlling
BCC/ACC	BCC	ACC	BP (S/D)-DCC	mean BP -DCC	of hypertension DCC
82/86	140/100,	130/85	220/130	50	2'
74/70	110/75,	135/90	165/100	50	3'
68/92	165/105,	145/100	165/105	45	3'30"
72/70	145/100,	130/90	185/95	50	2'40"
78/86	130/80,	125/85	160/90	35	3'20"
60/72	145/95,	155/90	165/105	40	1'20"
74/69	140/85,	130/90	185/105	50	1'
81/73	130/60,	120/60	165/90	45	1'

HR: Heart rate, BP: Blood pressure (mmHg), S/D: Systolic/diastolic, BCC: Before cross-clamping, DCC: During cross-clamping, ACC: After cross-clamp.

1116 ml. per patient. With the use of cell saver system, large amounts of blood was preserved. Autotransfusion by a cell saver device was used in all cases. Differences in preoperative and postoperative heart rates did not show any significance. Similarly preoperative postoperative systolic and diastolic blood presure differences were not significant.

The arterial hypertension observed after placing the cross-clamps was controlled in an average of 2 minutes.

Arteria radicularis magna or large intercostal arteries were not encountered in any of the cases, and therefore anasthomosis to the graft was not applied.

Mortality was not seen in our 8 patients. Similarly we have not encountered any paraplegia. In 1 patient febrile reaction, in 1 patient nervus recurrens trauma, and in 1 patient subcutaneus infection was seen.

Discussion

Clamping of proximal descending thoracic aorta during surgical intervention in cases without chronic obstructive vascular disease leads to sudden and serious rise in peripheral resistance and left ventricular afterload[1-8].

This rise may create a strain to heart that may result in ventricular fibrillation, heart failure or cardiac arrest. On the other hand, crossclamping of both proximal and distal descending aorta may lead to transient or irreversible ischemic changes in distal organs, particularly in spinal medulla and kidneys. These untoward effects can be expected especially in cases with longer cross- clamp times and/or insufficient collateral circulation. The limits for cross-clamp time are not known and it is very difficult to determine the status of collateral circulation in most clinical cases, particularly in those without coarctation[2]. For this reason, surgeons have developed several bypass techniques to perfuse the distal parts during operation. Despite

the use of these techniques, mortality rate in operations has been reported between 9-21% and the incidence of paraplegia 1-11%[2-9,13,15,18-20].

Crawford and his colleques reported a mortality rate of 22% and an incidence of paraplegia about 6% in 36 cases treated by shunt technique[8]. The same authors reported a mortality rate of 6% and no paraplegia in another series of patients treated without using shunt and perfusion between 1976 and 1980[8]. Another series from Crowford which has given long term results of 605 patients, supports the points given above[8,9,18, 29].

Cooley and his colleques explained the convenience of surgical treatment of aneurysms of the descending thoracic aorta with this technique in 15 cases without perfusion or shunt, while attaching importance to "Innominate Factor".

We had also used most of these techniques in the past but nowadays, we don't use extracorporeal shunts and bypasses in such cases. We rely upon the adaptability of the circulatory system in the preservation of the heart, the brain, the spinal cord, visceral and distal organs during the critical period, up to the release of aortic cross-clamp with complete reestablishment of circulation again[4,25, 29].

Complications such as renal failure, paraplegia, and mortality did not occur. Since we could manage hemodynamic changes appearing after declamping by pharmacological agents, we feel justified to choose inclusion technique in treating aneurysms of thoracic aorta[5, 25, 29].

According to Wright, among patients not treated surgically, only 5% of the patients survived 5 years. According to Hufnagel, 80% of those not treated, died within 3 years and 95% within 5 years.

These studies have indicated that aneurysms of descending aorta could be managed better and more reliably than by using bypass shunts. Because inclusion technique has facilitated the operation and is also far from the complications of shunt and by-pass. The most important added means of managing hemodynamics of proximal circulation by means of pharmacological agents and necessary fluid replacement given at the right time[5]. This is quite clear, because with such improvements in this technique, paraplegia has hot occured in Crawford's 4-year study and the mortality rate has decreased to 6%. Recent studies have also supported these results. Clamping of the aorta distal to left subclavian artery normally does not cause paraplegia, because in these patients the internal mammary artery provides sufficient flow to intercostal circulation, via which the spinal circulation receives it's blood supply, providing enough flow to radicular artery[6-10,17,18,24-29].

Renal failure and paraplegia developed in some cases with hypotension or low perfusion pressure resulting from technical errors. These serious complications were minimized by the use of the inclusion technique. As a result, surgical technique does not cause significant harm to the intercostal, mediastinal, renal and spinal arteries. Even more, enforces collateral circulation by making them work better[14, 15, 21-29].

"This is the adaptation ability of the organism to stressfull conditions", Cooley says[3]. It limits bleeding during and after operation and makes it possible to perform the operation in a tolerable cross-clamp time. Athough cooking of the graft with serum and the patient's own blood decreases leakage significantly, it creates several

manipulative problems at the operation (such as difficulty in suturing the grafts). We do not use heparin during surgical interventions in which the inclusion technique is being used. Although heparin was not used in these cases, we did not observe any central or peripheral emboli. No bleeding was observed among our patients.

Our technique relies upon the same main principle as inclusion technique. But by "double cross clamps technique", we believe that we have shortened the cross-clamp time, obtained more bloodless surgical area, and blood loss was much lesser. Because, we didn't spend the time for incising, cleaning the aneurysmal sac and for hemostasis during cross-clamp period. We performed all these maneuvers after the completion of the aortic continuity by bypass graft.

Conclusion

These results have shown that the aneurysms of the descending thoracic aorta could be repaired more reliably by "double cross-clamps technique" without using shunt and bypass techniques, and this approach appears a unique, safe and the most reliable surgical treatment.

We believe that this technique has important practical assets and indispensable advantages. We have come to the conclusion that this technique should be used in all appropriate cases.

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