Anesthetic management of descending thoracic aortobifemoral bypass for aortoiliac occlusive disease: Our experience

Anjum Saiyed, Reema Meena,
Indu Verma, C. K. Vyas

Department of Anaesthesiology,
SMS Medical College and
Associated Group of Hospitals,
Jaipur, Rajasthan, India

A B S T R A C T

Background: Complete obstruction of the abdominal aorta at the renal artery level is a difficult surgical problem. Aortic clamping and declamping can lead to profound haemodynamic changes, myocardial infarction, ventricular failure or even death may result. These complications are important challenges in anesthetic management of these patients. **Methods:** Between August, 2010 and April, 2012, descending thoracic aorta to femoral artery bypass grafting was used to revascularize lower limbs in 11 patients in our institute. The anesthetic management of these patients is described here. Epidural catheter placement was done in T 5-6 or T 6-7 space for post operative pain relief. Induction was done by, Inj. Glycopyrolate 0.2 mg, Inj. Fentanyl 5 μg/kg., Inj. Pentothal sodium 5 mg/kg, Inj. Rocuronium 0.9 mg/kg, IPPV done. Left sided double lumen tube was inserted, Maintenance of Anesthesia was done by $O_2 + N_2O$ (30:70). Increments of Vecuronium and Fentanyl were given Monitoring of Heart rate, arterial pressure, central venous pressure were continuously displayed. The available pharmacological agents were used when there is deviation of more than 15% from base line. **Results:** In our study, inspite of measures taken to control rise in blood pressure during aortic cross clamping, a rise of 90 mm of Hg in one patient and 60-80 mm of Hg in four patients was observed, which was managed by sodium nitropruside infusion. At the end of surgery seven patients were extubated on the operation table. In remaining four patients DLT was replaced by single lumen endotracheal tube and were shifted to ICU on IPPV. They weaned off gradually in 3-5 hours. In our series blood loss was 400 ml to 1000 ml. There was no mortality in the first 24 hours. Postoperative bleeding was reported in one case which was re-explored and stood well. **Conclusion:** The anesthetic technique during aortic surgery is directed at minimizing the hemodynamic effects of cross clamping in order to maintain the myocardial oxygen supply demand ratio.

Key words: *Aortobifemoral bypass, aortoiliac occlusive disease, descending thoracic aorta, juxtarenal occlusion*

Address for correspondence:
Dr. Anjum Saiyed,
J-180 Rajiv Gandhi Marg,
Adarsh Nagar,
Jaipur, Rajasthan, India.
E-mail: dranjumsaiyed@gmail.com

INTRODUCTION

Atherosclerotic disease is generally diffuse involving single or multiple regions of blood vessel. Atherosclerosis of peripheral arterial system contributes to significant morbidity and mortality. The standard method of aortoiliac revascularization for occlusive disease is through a transabdominal approach.

When this option is considered hazardous or not feasible, the usual alternative is axillobifemoral bypass. Axillobifemoral bypass is suitable for certain patients with high medical risk. However, a more durable, long-term alternative is desirable for those with a longer life expectancy.[1]

Descending thoracic aorta to femoral artery bypass has major advantages over axillofemoral bypass because it provides better inflow, requires a shorter graft length, offers better protection of the graft from infection and mechanical trauma, and carries a superior patency rate.[2]

The purpose of the study was to discuss anesthetic management and problems of aortic cross clamping which is the major anesthetic challenge. The anesthetist should be aware of the problems of proximal aortic clamping, renal preservation during clamping and

declamping of the aorta posed by this surgical approach, and the potential need for massive blood transfusion with its associate problems.

The anesthetic management and the problem faced by anesthetist during these surgeries are discussed with particular emphasis on the consequences and management of aortic cross clamping.

METHOD

Eleven patients were treated with descending thoracic aortobifemoral bypass for aortoiliac occlusive disease between August, 2010 and April, 2012. Demographic data, comorbid factors, and preoperative finding were noted [Table 1].

Age of the patients ranged from 48 to 77 years (mean, 59 years). All patients were male. Weight of the patients ranged from 40 to 70 kg (mean, 55 kg).

All patients had disabling intermittent claudication or rest pain. Five patients had ischemic ulcers; four had gangrenous toes or distal foot.

Angiography revealed stenosis of infrarenal aorta, juxtarenal aortic occlusion, and stenosis of common and external iliac artery in all cases [Figure 1]. Abdominal aortobifemoral was considered to be hazardous as there was no suitable site for aortic cross clamping.

Pulmonary function tests showed mild chronic obstructive pulmonary disease in four, moderate obstructive changes in two, normal in four, and severe restrictive changes in one patient. Other comorbidities were coronary artery disease in two patients, hypertension in seven, renal impairment in two patients, and diabetes in one patient.

COPD: chronic obstructive pulmonary disease
CAD: coronary artery disease

Anesthetic Management

All the patients were evaluated thoroughly in the preoperative visit.

One day before operation, all patients were taken in the operation theater for thoracic epidural catheter placement in T 5-6 or T 6-7 space for postoperative pain relief.

All patients received oral premedication with Tab. Alprazolam 0.5 mg. at 6 a.m and patients who were on anti-hypertensive drugs were also given with a sip of water. On arrival in the O.T., IV access was taken on dorsum of left hand by 18G. cannula. ECG (electrocardiography) electrodes were applied and after sedation with IV midazolam 2 mg, radial artery cannulation was done. Right internal jugular vein was cannulated for CVP (cental venous pressure) measurement under local anesthesia.

Figure 1: Preoperative angiography

Table 1: Demographic data and preoperative findings

Case No.	Age (Years)	Weight (Kg.)	Comorbidities				
			Renal	Lung	CAD	Diabetes	Hypertension
1.	51	50	Mild elevation	COPD	no	No	yes
2.	77	40	No	No	yes	No	yes
3.	59	70	No	COPD	no	Yes	No
4.	69	65	No	Mod. Obst.	no	No	yes
5.	58	60	Mild elevation	No	no	No	No
6.	60	55	No	Mod Obstruction.	no	No	yes
7.	48	60	No	COPD	no	No	No
8.	62	50	No	Severe restriction.	yes	No	yes
9.	54	65	No	No	no	No	No
10.	58	62	No	COPD	no	No	No
11.	54	59	No	No	no	No	yes

Induction was done by Inj. Glycopyrrolate 0.2 mg, Inj. Fentanyl 5 µg/kg., Inj. Pentothal sodium 5 mg/kg, Inj. Rocuronium 0.9 mg/kg, IPPV(Intermittent positive pressure ventilation) done.

Left-sided double lumen tube (DLT) was inserted; appropriate maneuver were carried out to ensure correct positioning of DLT before and after positioning of the patients.

Maintenance of anesthesia was done by O_2 + N_2O (30:70). Increments of Vecuronium and Fentanyl were given during the procedure.

After induction, patients were catheterized by Foley's catheter, nasogastric tube was introduced and checked, and temperature probe was introduced in the nasopharynx.

Monitoring of heart rate, ECG, arterial pressure, and central venous pressure were continuously displayed [Table 2]. The available pharmacological agents were used when there is deviation of more than 15% from the baseline.

$EtCo_2$ (End-tidal carbon dioxide tension), Spo_2, temperature, and urine output were monitored.

In order to facilitate an instantaneous response to change in hemodynamic parameters, during surgery Inj. Sodium nitroprusside (50 mg in 500 ml 5% dextrose. conc.100 mic/ml), Inj. Dopamine (400 mg in 500 ml 5% dextrose conc. 800 µg/ml), and Inj. Nitroglycerine (50 mg in 500 ml 5% dextrose conc. 100 µg /ml) were prepared and connected with infusion pump.

The patients were positioned with the left hemithorax elevated 30 to 45° and pelvis as flat as possible to allow access to both groins [Figure 2].

Surgical Technique

The chest, abdomen, and both groins were prepared and draped. Antero-lateral thoracotomy was done, via the 7th intercostals space. Proximal anastomosis of a 14 × 7 mm Dacron bifurcated graft was performed end-to-side at the lower descending thoracic aorta [Figure 3]. The graft limbs were drawn through a tunnel between rectus abdominal muscle and peritoneum to a short midline incision at level of umbilicus, from which each limb of the graft was drawn through a subcutaneous tunnel to each side of the groin and anastomosed to each common femoral artery.

Aortic cross clamping

In order to decrease the likelihood of an initial massive rise in systolic blood pressure, the aortic clamp was not applied until the effect of the vasodilator infusion was apparent.

$EtCO_2$ was maintained between 18-35 mmHg. Fractional inspired oxygen concentration (Fio_2) was increased from 0.3 to 0.5 during one lung ventilation.

Figure 2: Patient position

| Table 2: Hemodynamic and ventilatory variables before cross clamping of aorta											
Cases	HR (Minute)	Systolic Pressure mm of Hg	Diastolic Pressure	Mean Pressure	$EtCO_2$ mm of Hg	SPO_2 %	Arterial Blood Gas				Airway Pressure cm of H_2O	
							pH	pO_2	pCO_2	Bicarbonate	BLV	OLV
1	65±5	120±10	80±10	93±10	18-20	98-99	7.34	200	40	22	17	29
2	62±3	140±10	95±5	109±6	25-29	97-98	7.32	208	31	21	18	30
3	75±5	125±25	85±5	98±12	22-26	95-97	7.40	210	34	23	19	28
4	80±5	137±3	77±7	97±6	21-24	98-99	7.33	220	32	26	16	29
5	100±5	105±5	65±5	78±5	24-26	97-98	7.36	203	40	26	20	27
6	85±5	130±10	80±5	103±7	23-45	98-99	7.37	210	35	22	21	30
7	67±3	110±10	72±3	85±5	19-22	96-97	7.33	208	36	24	25	35
8	89±3	150±10	92±7	111±9	25-29	95-96	7.39	190	37	28	29	39
9	65±5	125±5	75±5	91±5	19-22	99-100	7.35	250	40	24	17	28
10	84±6	140±10	70±10	94±12	22-25	97-99	7.38	219	40	20	16	32
11	110±10	130±10	75±5	86±6	26-30	96-99	7.40	190	44	24	19	31
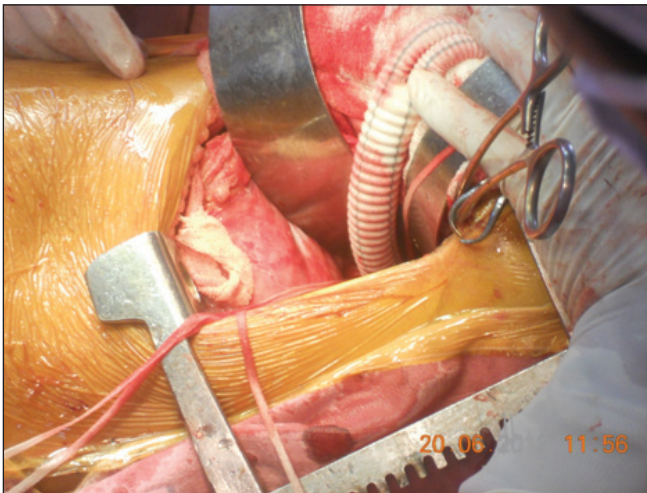
Figure 3: Aortobifemoral bypass graft in-situ

Patients were heparinized with inj. Heparin 1 mg/kg 5 minutes prior to aortic cross clamping.

Arterial blood gas was measured, and if metabolic acidosis was found, it was corrected by inj. sodium bicarbonate.

In our series, clamp time varied from 15 to 35 minutes

Aortic declamping

Vasodilator therapy was discontinued and fluid volume was transfused to keep CVP above 10 cm of H_2O.

All patients received 25 g mannitol to improve urine flow following the period of renal ischemia.

Blood transfusion and fluid management were done according to losses. In our series, no patients required massive blood transfusion. Transfusion of blood varied from 400 to 1000 ml of whole blood.

At the end of surgery, of 11 patients, seven of them were extubated on the operation table after proper reversal. In the remaining four patients, DLT was replaced by single lumen endotracheal tube and were shifted to ICU on IPPV. They weaned off gradually in 3 to 5 hours. Postoperative pain relief was done by continuous infusion of inj. Ropivacaine 0.2% 8 ml/hour for 48 hours. Thoracic epidural catheter was removed after all aseptic precaution and watched for bleeding from the site.

Postoperatively (3 weeks after surgery) CT angiography was done showing good flow in the Aortobifemoral grafts [Figure 4].

DISCUSSION

Descending thoracic aorta to femoral artery bypass grafting is considered a good alternative procedure for revascularization in cases of aortic graft failure, graft infection, and other intra-abdominal pathologies not amenable to standard aortofemoral revascularization. Thoracofemoral bypass was first described by Blaisdell *et al.*[3] as an alternative to the standard aortofemoral bypass. Subsequently, several groups have recommended this technique as an alternative or first choice procedure for aortoiliac occlusion.[4,5]

Thoracic aortic cross clamping with pharmacological control of cardiovascular hemodynamics, described by Crawford, is associated with increased survival and fewer complications.[6] The hemodynamic response to aortic cross clamping depends on the site of clamping, the presence or absence of collateral vessels, and left ventricular function. Infrarenal cross clamping is associated with a 36 to 40% increase in vascular resistance.[7,8] The viscera and liver receive 30% of cardiac output and the kidneys just under 25%[9] so that clamping above the coeliac axis is likely to cause greater hemodynamic changes. Thoracic aortic clamping can cause a rise of 68% in total peripheral resistance compared with baseline values.[10] In our study, despite of measures taken to control rise in blood pressure during aortic cross clamping, a rise of 90 mm of Hg in one patient and 60 to 80 mm of Hg in four patients was observed [Table 3], which was managed by sodium nitroprusside infusion at the rate of 3 to 60 ml/hour. Aortic clamping above the coeliac artery decreases ejection fraction and produces ventricular wall motion abnormalities, stroke volume and cardiac output therefore fall which can be determined by transesophageal echocardiography.[11]

Patients with coronary artery disease are at greater risk of reduction in cardiac output than those with normal myocardial function.[12,13] In one of our patient who was a known case of CAD, we preferred to infuse NTG during aortic cross clamping as it may be useful in these patients to reduce PCWP and improve myocardial contractility by moving them to more favorable position on the frank–Starling curve.[14]

Heart rate is a determinant of coronary artery blood flow and is of particular importance in patients with coronary artery disease in whom tachycardia may lead to myocardial ischemia. In such patients, we used esmolol 0.5 mg/kg. The cardiac output measurement was not possible in our series as we did not put pulmonary artery catheter, so ventricular functions were assessed indirectly by arterial pressure and CVP.

Cross clamping of the thoracic aorta decreases renal blood flow by 85 to 94%.[15] In anticipation of renal ischemia, we infused mannitol 25 g during aortic clamp. Patients were

observed for urine output continuously and none of our patients had decrease in urine output.

Hypotension following aortic declamping occurs because of sudden fall in peripheral vascular resistance and blood loss from the graft. Reduced distal organ perfusion also causes a metabolic acidosis on clamp release, leading to dysrhythmias and myocardial depression. To prevent hypotension, vasodilator therapy was discontinued and fluid volume was transfused to keep CVP above 10 cm of
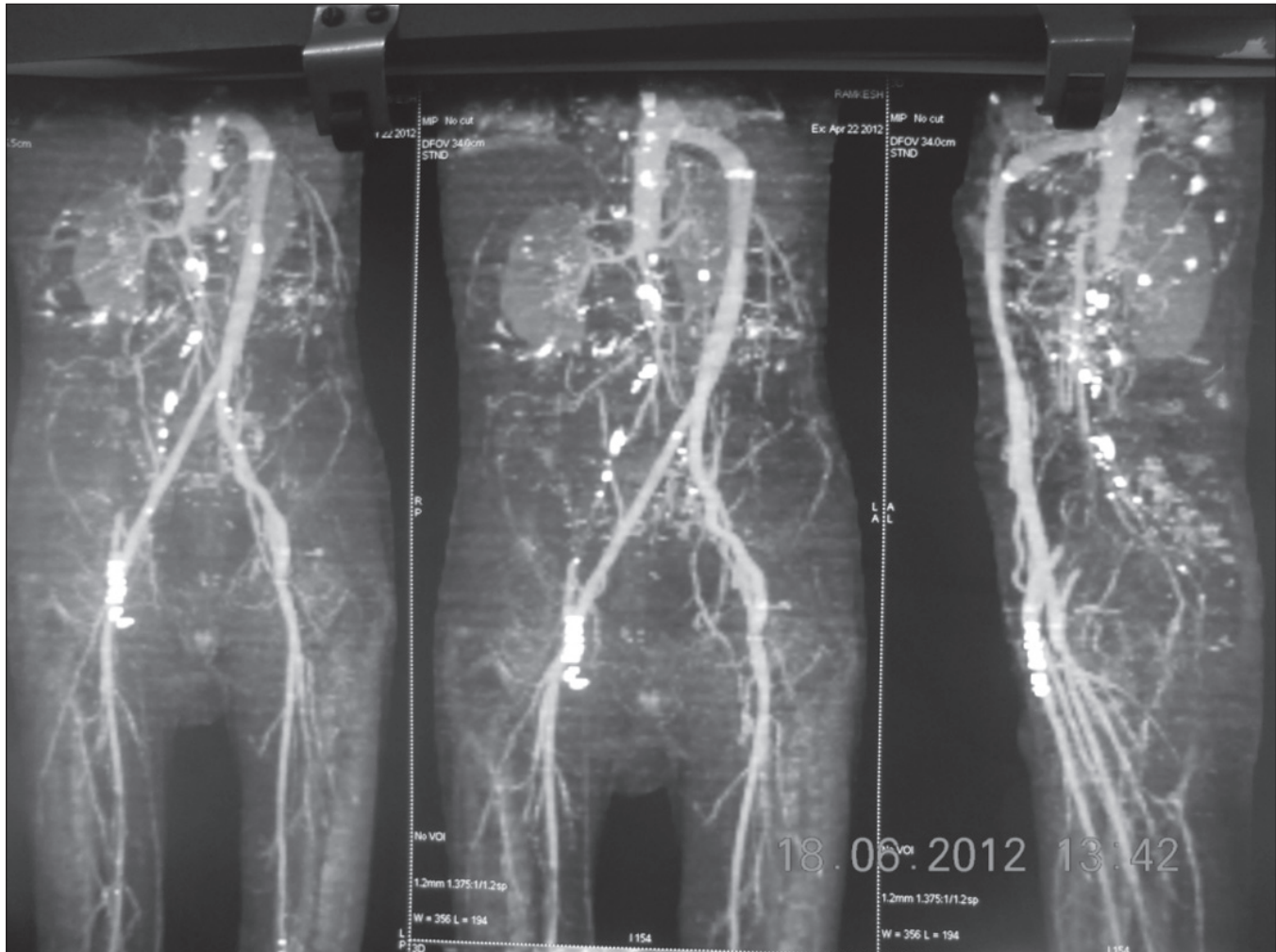

Figure 4: Postoperative CT angiography

Table 3: Hemodynamic and ventilatory variables during cross clamping of aorta

| Cases | HR (Minute) | Systolic Pressure | Diastolic Pressure | Mean Pressure | EtCO$_2$ mm of Hg | SPO$_2$ % | Arterial Blood Gas | | | | Airway Pressure cm of H$_2$O | |
		mm of Hg					pH	pO$_2$	pCO$_2$	Bicarbonate	BLV	OLV
1	73±7	125±25	76±4	98±18	18-20	98-99	7.4	2.98	40	24	17	30
2	85±5	130±10	105±5	113±10	26-29	96-98	7.32	260	37	22	18	32
3	94±6	160±30	90±10	106±13	21-27	97-98	7.36	216	34	23	19	29
4	100±10	160±20	80±10	106±13	23-26	98-99	7.33	209	33	26	20	30
5	105±5	165±25	85±5	111±11	24-27	97-98	7.40	203	41	22	22	28
6	95±5	140±10	95±5	109±14	24-26	98-99	7.38	198	36	24	24	32
7	97±2	170±30	90±5	116±16	20-22	96-99	7.33	199	35	28	25	30
8	80±10	145±15	85±15	105±15	24-29	99-100	7.40	200	39	24	19	35
9	90±10	135±5	85±5	98±5	20-22	97-99	7.28	216	41	20	17	28
10	98±1	130±10	103±3	113±13	22-35	96-99	7.36	226	43	24	16	32
11	92±7	170±10	100±10	126±7	26-30	98-99	7.40	208	43	24	20	35

H$_2$O; despite of this, systolic pressure fell to 50-80 mm of Hg in six patients, with little or no change in the remaining five patients [Table 4]. In the three patients, restoration of blood pressure was achieved by rapid infusion of blood and in the other three patients, Dopamine @5 ml/hour was also infused. Massive blood loss can occur during graft replacement and needs careful management. Blood transfusion and fluid management was done according to losses. In our series, transfusion of blood varied from 400 to 1000 ml of whole blood [Table 5]. The hemodynamic events of declamping can be avoided by the administration of intravenous fluids, correction of acidosis, and electrolyte imbalance with increments of inj. sodabicarb 7.5% before release of aortic clamp and if needed use of inotropes. Saleh *et al.* preferred continuous infusion of bicarbonate instead of bolus administration in the prevention of systemic acidosis.[16] Temporary or permanent ischemia of organs distal to the site of aortic clamping may result if clamp time is prolonged or collateral circulation is cut off. In our series, clamp time varied from 15 to 35 minutes and also there might be presence of collateral vessels in patients of chronic obstruction of aorta;[17] hence, we did not face such problem.

The major limitation to this surgical technique is the morbidity rate associated with thoracotomy in a relatively high-risk vascular surgery population. The minimally invasive video endoscopic procedure has been shown to improve the post-operative course and comfort of patients in general and thoracic surgery. The same benefits could be expected from a video endoscopic surgery involving the thoracic aorta.[18]

Summary

The problems of anesthesia during aortic surgery have been outlined. The hemodynamic consequences of thoracic aortic cross clamping and the method employed to overcome them have been discussed. The results of surgery in 11 patients have been presented.

The anesthetic technique during aortic surgery is directed at minimizing the hemodynamic effects of cross clamping in order to maintain the myocardial oxygen supply demand ratio. Dysrhythmias, myocardial infarction, and ventricular failure may otherwise occur. For success in such major surgery, a thorough preoperative assessment of the patients should be done to optimize the condition. Close

Table 4: Hemodynamic and ventilatory variables after de clamping of aorta

Cases	HR (Minute)	Systolic Pressure	Diastolic Pressure mm of Hg	Mean Pressure	EtCO$_2$ mm of Hg	SPO$_2$%	Arterial Blood Gas				Airway Pressure cm of H$_2$O	
							pH	pO$_2$	pCO2	Bicarbonate	BLV	OLV
1	75±5	95±5	55±5	68±5	20-22	97-99	7.38	216	38	22	16	28
2	85±5	85±5	45±5	58±5	24-28	97-98	7.33	220	34	24	18	29
3	95±5	90±5	70±5	76±10	21-25	95-97	7.42	210	32	26	20	27
4	105±5	130±10	75±5	91±8	20-26	96-97	7.28	208	40	20	17	29
5	103±3	120±10	55±5	76±6	24-26	97-99	7.35	198	40	22	22	29
6	100±10	90±20	70±20	76±20	23-26	95-98	7.38	226	36	24	20	30
7	85±5	100±10	65±5	75±5	20-22	94-97	7.20	240	36	18	25	35
8	85±5	140±10	85±5	101±8	25-29	95-98	7.22	196	38	19	29	39
9	90±10	90±30	60±20	80±13	19-22	99-100	7.30	240	36	20	16	27
10	94±6	120±50	75±15	89±26	20-24	98-99	7.38	206	42	22	17	32
11	95±5	140±10	91±9	106±10	27-29	96-99	7.35	224	44	24	19	33

EtCO$_2$: End-tidal carbon dioxide tension

Table 5: Operative data and outcome

Case	Clam Time (Minute)	Blood loss (ml)	Duration of Surgery (hours)	Events during Surgery	Events in ICU
1	35	1000	4.5	Uneventful	Re explored
2	30	700	3.8	ST Segment changes	Extubated after 5 hours
3	25	650	3.2	Uneventful	Uneventful
4	15	400	2.6	Uneventful	Uneventful
5	26	600	3.5	Uneventful	Uneventful
6	20	400	2.8	Uneventful	Uneventful
7	28	500	3.0	Uneventful	Extubated after 3 hours
8	30	800	3.6	Uneventful	Extubated after 4 hours
9	20	450	2.5	Uneventful	Uneventful
10	35	550	8.4	Uneventful	Extubated after 3 hours
11	25	400	2.8	Uneventful	Uneventful

monitoring of hemodynamic parameters and their rapid control during clamping and declamping is essential. Need for close cooperation between surgeon and anesthetist at all stages should be emphasized.

ACKNOWLEDGMENT

REFERENCES

1. Ihaya A, Chiba Y, Kimura T, Morioka K, Ueska T. Descending thoracic aortobifemoral bypass for aortoiliac occlusive disease. Asian Cardiovasc Thorac Ann 2001;9:97-100.
2. Passman MA, Taylor LM, Moneta GL, Edwards JM, Yeager RA, McConnell DB, et al. Comparison of axillofemoral and aortofemoral bypass for aortoilliac occlusive disease. J Vasc Surg 1996;23:263-71.
3. Blaisdell FW, McMattei GA, Gauder PJ. Extraperitoeal thoracic aorta bifurcation prosthesis: Case reports. Am J Surg 1961;102:583-5.
4. McCarthy WJ, Mesh CL, McMillan WD, Flinn WR, Pearce WH, Yao JS. Descending thoracic aorto-to-femoral artery bypass: 10 years' experience with a durable procedure. J Vasc Surg 1993;17:336-48.
5. Branchereau A, Magnan PE, Moracchini P, Espinoza H, Mathieu J. Use of descending thoracic aorta for lower limb revascularization. Eur J Vasc Surg 1992;6:255-62.
6. Crawford ES, Walker HS, Saleh SA, Normann NA. Graft replacement of aneurysm in descending thoracic aorta: Results without bypass or shunting. Surgery 1981;89:73-85.
7. Meloche R, Pottecher T, Audet J, Dufresne O, LePage C. Hemodynamic Challenges due to clamping of the abdominal aorta. Can Anaesth Soc J 1977;24:20-34.
8. Silverstein PR, Caldera DL, Cullen DJ, Davison JK, Darling RC, Emerson CW. Avoiding the hemodynamic consequences of aortic cross clamping and unclamping. Anesthesiology 1979;50:462-6.
9. Ganong WF. Review of medical physiology. Los Altos, California: Lange Medical Publications; 1983.
10. Brusoni B, Colombo A, Merlo L, Marchetti G, Longo T. Hemodynamic and metabolic changes induced by temporary clamping of the thoracic aorta. Eur Surg Res 1978;10:206-16.
11. Roizen MF, Beaupre PN, Alpert RA, Kremer P, Cahalan MK, Shiller N, et al. Monitoring with two dimensional transesophageal echocardiography. Comparison of myocardial function in patients undergoing supraceliac, suprarenal-infraceliac, or infrarenal aortic occlusion. J Vasc Surg 1984;11:300-5.
12. Lunn JK, Dannemiller FJ, Stanley TH. Cardiovascular responses to clamping of the aorta during epidural and general anesthesia. Anesth Analg (Cleve) 1979; 58:372-6.
13. Cohn JN, Franciosa JA. Vasodilator therapy of cardiac failure: (first of two parts). N Engl J Med 1977;297:27-31.
14. Zaidan JR, Guffin AV, Perdue G, Smith R, McNeill DC. Hemodynamics of intravenous nitraoglycerin during aortic clamping. Arch Surg 1982;117:1285-8.
15. Gelman S, Reves JG, Fowler K, Samuelson PN, Lell WA, Smith LR. Regional blood flow during cross-clamping of the thoracic aorta and infusion of sodium nitoprusside. J Thrac Cadiovasc Surg 1983;85:287-91.
16. Saleh SA, Crawford ES, Boberger RA, Ridgley E, Morrow DH. Intraoperative acid-base management for the resection of thoracoabdominal aneurysms: A comparison of continuous infusion of sodium bicarbonate versus the bolus. Anesth Analg (Cleve) 1982;61:213A
17. Dunn E, Prager RL, Fry W, Krish M. The effect of abdominal aortic cross-clamping on myocardial function. J Surg Res 1977;22:463-8.
18. Fukui S, Paraskevas N, Sourty P, Gigou F. Totally videoendoscopic descending thoracic aorta to femoral artery bypass grafting. J Vasc Surg 2010;51:1560-3.