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ORIGINAL: Evaluation of Hemodynamic Changes in Patients with Carotid Stenosis Undergoing Carotid Endarterectomy in Razi Hospital

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ABSTRACT

Introduction: The purpose of this longitudinal study was to determine the extent of hemodynamic changes after carotid antrectomy in patients with carotid artery stenosis hospitalization to intensive care unit (ICU) of Razi Hospital and how factors affect it and provide necessary measures to improve blood pressure control and increase the quality of life in these patients.

Material and Methods: This is a longitudinal study in which all patients with carotid artery stenosis referred to Razi Hospital of Rasht from 2006 to 2016 who underwent carotid endarterectomy were enrolled. Changes in vital signs including systolic and diastolic pressure, heart rate and body temperature of patients who were checked every 6 hours before and after surgery, in the second 24 hours after surgery, ICU, Length of hospital stay and ICU mortality were recorded.

Results: In this study, the mean age of patients was 68.42 ± 9.97 years. Sixty-four (97%) patients had at least one underlying disease. Our results showed that there was a statistically significant difference in systolic blood pressure at the time of surgery. Means preoperative systolic blood pressure was 119.89±11.89 and this mean increases to 138.89±16.66 at 48 hours after surgery.

Conclusion: The results of this study showed that blood pressure control in patients with blood pressure changes during and after surgery; hemodynamic changes after endarterectomy and the everyday dangers of cerebral hemorrhage decreased and prevented vascular thrombosis. It can be concluded that controlling hemodynamic parameters as well as vital signs of patients resulted in the relative stability of these parameters. Ultimately the death rate slaked to nought.

Introduction

Atherosclerosis is the most common cause of death and disability in societies (1). Atherosclerotic diseases can lead to ischemic-cerebrovascular events. Obstructive atherosclerotic plaques, with a huge difference, is the most common pathology of the carotid bifurcation. 30 to 60% of ischemic strokes are associated with obstructive atherosclerotic diseases carotid bifurcation occurs (2). Approximately

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700,000 Americans experience a stroke, new or recurrent, each year. 85% of all strokes were ischemic, and the remaining 15% are hemorrhagic. Ischemic strokes usually occur due to hypoperfusion that caused by arterial obstruction or less commonly, which succeed by decreased blood flow that resulted from proximal arterial stenosis and weak lateral network. Common causes of ischemic strokes are cardiac embolism (35%), carotid artery disease (30%), lacunar (10%), miscarriage (10%) and idiopathic (15%) (3).

Stroke caused by obstructive diseases in the carotid bifurcation is usually due to atherosclerosis. Atherosclerotic plaque formation is a complex process and started from damage to the intima layer, platelet aggregation, proliferation of smooth muscle cells, and fibroplasia. It ends up narrowing the artery. As the number of stenosis increases, Blood flow becomes more whirlpool mod, and this increases the risk of developing atherosclerosis (4). The severity of stenosis is usually divided into three categories, based on the reduced diameter of the vessel duct: Mild (less than 50% duct diameter), moderate (between 50 to 69% duct diameter) and severe (between 70 to 99% duct diameter). Severe carotid stenosis strongly predicts stroke (2). Increased age, male gender, hypertension, smoking, diabetes mellitus, homocysteinemia, and hyperlipidemia are well known underlying factors for the development and progression of obstructive atherosclerotic diseases (2).

Duplex ultrasound is the most common screening tool for the evaluation of atherosclerotic plaques and extracranial carotid artery stenosis (5). Duplex is also commonly used for continuous monitoring of disease progression or after the therapeutic intervention (terminal endarterectomy or carotid angioplasty). Carotid artery duplex ultrasound is a combination of type B ultrasound and Doppler wave analysis (6). Patients with obstructive aortic bifurcation are usually divided into two groups: Patients with no previous history of stroke or TIA on the concordant side of the lesion (asymptomatic) and those who formerly or recently have had nerve symptoms in the accompanying (symptomatic) stroke (7). Atherosclerosis is the most common cause of death and disability in societies (1,8). Atherosclerotic diseases can lead to ischemic-cerebrovascular events (9). Typical cerebral ischemic events are characterized by the sudden onset of focal neurological defects. The incidence of stroke among different countries, and it increases progressively with age (10) and in Central Asia and North Africa, it is increasingly becoming a significant health problem (11). Stroke is the second leading cause of death worldwide (12).

Treatment of patients with asymptomatic carotid artery stenosis includes treatment alone, carotid endarterectomy plus medical treatment, or carotid artery stenting plus medical treatment (13). In patients with severe symptomatic carotid artery stenosis, CEA is the standard therapy. It has also been shown that surgical treatment is preferred over medical treatment in patients younger than 75 years with severe asymptomatic carotid artery stenosis (14). Vascular regeneration procedures such as CEA and CAS can be useful for patients with internal carotid artery stenosis, as they not only reduce the likelihood of embolic events but also improve the hemodynamic status of the brain (15). The complexity that occurs after CEA includes blood pressure changes and appears to be due to differences in baroreceptor performance due to surgical dissection and possible cross-clamping effects (16). A study found a significant increase in blood pressure by 56% and a decrease in 40% of patients undergoing carotid endarterectomy. Hemodynamic instability after carotid endarterectomy usually requires intravenous vasoactive medication (IVMED) administration and may lead to prolonged hospital and ICU hospitalization. Potential hypertension leads to hematoma of the ulcer, brain and cardiac complications, and exacerbation of the complication of cerebral hyperperfusion syndrome. Hypotension can also decrease cardiac and cerebral perfusion that might be

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led to MI or ischemic stroke (17, 18). Some studies have reported an increase in mortality and morbidity in patients undergoing hemodynamic changes after carotid endarterectomy, while others did not report differences in results. Despite these concerns, the short-term and long-term clinical effects of postoperative hemodynamic changes are unclear (19) that turn the carotid endarterectomy to the gold standard in the treatment of extracranial carotid stenosis (20) and the surgery department of Razi educational Hospital, as the only state-run vascular surgery center, is in charge of the operation. On the other hand, despite performing endarterectomy at the only public Guilan vascular surgery center, there is no information on post-CEA hemodynamic changes in patients at this center and this study was designed to determine post-CEA hemodynamic changes.

Methods

This is a longitudinal study in which all patients with carotid artery stenosis referred to Razi Hospital of Rasht from 2006 to 2016 who underwent carotid endarterectomy were enrolled. Patients with incomplete records were excluded from the study. Patient's data collection tools include a checklist containing demographic information (age, sex, BMI), underlying diseases (such as diabetes, hypertension, cardiovascular disease, etc.), history of medication at the time of admission to hospital, information on blood pressure changes such as MAP (mean arterial blood pressure) preoperatively, Then in the first 24 hours after surgery; every six hours and the second 24 hours after surgery; every 12 hours. Changes in vital signs of patients (Including systolic blood pressure, diastolic blood pressure, and heart rate and body temperature of patients preoperatively, and then in the first 24 hours after surgery; every 6 hours and in the second 24 hours after surgery; Checked every 12 hours), Duration of ICU admission, length of hospital stay, mortality rate in ICU, also taking any blood pressure-lowering medication in ICU after endarterectomy such as TNG infusion and blood pressure-lowering pills were recorded in the ICU. If patients were connected to the ventilator after surgery; the duration of the ventilator connection was also recorded. The collected data were entered into Stata 12 software. Mean, and standard deviation was used to describe the quantitative variables. Qualitative variables were also defined based on numbers and percentages. The Normal distribution of the quantitative variables of the study was measured using the Shapiro-Wilk test. Changes in vital signs and hemodynamic parameters (body temperature, heart rate, systolic blood pressure, diastolic blood pressure and mean arterial blood pressure) were then compared using the Skillings – Mack test (20). P-value < 0.05 was considered statistically Significant.

Results

In the present study, 66 patients with carotid artery endarterectomy were evaluated whose data were available. The mean age of the patients was 68.42 ± 9.97 years, with a median age of 69 and range of 40 to 87 years. More than half of the subjects were male (66.7%). Body mass index was higher in overweight and obese subjects (75.8%). From a history of medicine consumption, Atorvastatin, ASA and OSVIX had the highest frequency (***Table 1***). The most frequent use of lipid-lowering drugs was, according to drug classifications. Results showed that 64 (97%) had at least one underlying disease. Among the underlying diseases, hypertension (HTN), stroke (CVA) and hyperlipidemia (HLP) were the most common (***Table 2)***. Also, five patients (7.6%) had carotid artery endarterectomy. According to the results, only three patients had endotracheal intubation in the ICU. The characteristics of patients undergoing tracheal intubation in the ICU after surgery (***Table 2)***. The Mean ± SD of hospital stay days for patients was 6.79 ± 4.55, and ICU stays days in patients undergoing carotid artery endarterectomy was 3.89 ± 3.53. Sixty-one patients (92.4%) in ICU used

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Table 1. Patient's drugs data

Score	Number (%)
Atorvastatin	57 (86.4)
Osvix	42 (63.6)
Amlodipine	20 (30.3)
Nitrocontin	12 (18.2)
Lasix	2 (3.0)
Propranolol	1 (1.5)
Triamterene H	1 (1.5)
Metoral	9 (13.6)
Valsartan	7 (10.6)
Diltiazem	6 (9.1)
Carvedilol	6 (9.1)
Atenolol	5 (7.6)
Hydrochlorothiazide	4 (6.1)

hypertensive medication. Among the blood pressure-lowering drugs in TNG, Losartan and Amlodipine were the most frequent (***Table 3***). The results of the evaluation of vital signs in patients undergoing carotid artery endarterectomy are presented in ***Table 4***. Some patients were discharged 24 hours (n = 3), 36 hours (n = 12) and 48 hours (n = 30) before the time points. The changes in body temperature, heart rate and systolic blood pressure at the time of measurement (6, 12, 18, 24, 36 and 48 hours after surgery) were statistically significant. There was no statistically significant difference in diastolic blood pressure and mean arterial blood pressure in patients undergoing carotid endarterectomy. Results of vital signs evaluation in patients undergoing hypertensive tablet ICU, are shown in Table 4. Some patients before 24 hours (two patients), 36 hours (n = 11) and 48 hours (n = 26) were discharged. Results showed that changes in body temperature, heart rate and systolic blood pressure at the time of measurement (6, 12, 18, 24, 36 and 48 hours after surgery) were statistically significant. There was no statistically significant difference in diastolic blood pressure and mean arterial blood pressure in patients undergoing carotid endarterectomy.

Discussion

Our results showed that the mean age of patients was 68.42 ± 9.97 years, According to the results, there was a statistically significant difference in systolic blood pressure at the time of surgery (6, 12, 18, 24, 36 and 48 hours after surgery) and an increase in systolic blood pressure was observed in the present study. Mean preoperative systolic blood pressure was 119.89±11.89 mmHg and postoperatively. This mean trend was higher, with mean systolic blood pressure 48 postoperatively 138.89±16.66 mmHg. However, despite the approximate stability of diastolic blood pressure and mean arterial hypertension after endarterectomy surgery, there was no statistically significant difference. There were no changes in diastolic blood pressure and mean arterial blood pressure. There were also statistically significant differences in other parameters of vital signs such as heart rate and body temperature. The results of this study are consistent with another similar study conducted at Boston University Hospital-Academic Center by Tan et al. showed that the mean age of patients was 64.12 ± 8.1 years (18, 21). It can be concluded that age as an underlying variable has an important role in the choice of surgery in patients with carotid stenosis. One of the important points to consider in similar studies is that high blood pressure is one of the complications of carotid artery endarterectomy. The researchers concluded that hypertension is associated with increased cardiovascular, cerebral and cardiac complications. Whereas, hypotension is associated with increased

Table 2. Characteristics of patients with tracheal intubation in the ICU after surgery

Age	Sex	History	Surgical side	Duration of connection to ventilator (Hours)	Duration of hospitalization (days)
84	Man	IHD, DM, HTN	Left	33	10
72	Female	CVA, HTN	Left	31	23
85	Man	IHD, HTN	Left	17	35

IHD: Ischemic heart diseases; DM: Diabetes Mellitus; HTN: Hypertension; CVA: Cerebrovascular accident

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Table 3. ICU blood pressure lowering medications in study subjects (n = 66)

Medication	Number (%)	Blood pressure lowering drug in people		
		Method of administration	Dosage (mg)	Number
Nitrinitroglycerin	51 (77.3)	Injection	10	17
			20	15
			30	9
			15	4
			4.5	3
			40	2
			5	1
losartan	26 (39.4)	Oral	25	21
			50	4
			12.5	1
Amlodipine	16 (24.2)	Oral	5	14
			2.5	1
			1	1
Nitrocontin	13 (19.7)	Oral	2.6	7
			6.4	6
Lasix	9 (13.6)	Oral	20	8
			40	1
Carvedilol	7 (10.6)	Oral	6.25	4
			12.5	3
Metoral	7 (10.6)	Oral	50	3
			25	3
			1	1
valsartan	6 (9.1)	Oral	80	3
			160	2
			40	1
Diltiazem	5 (7.6)	Oral	60	4
			30	1
captopril	5 (7.6)	Oral	25	4
			12.5	1
Atenolol	4 (6.1)	Oral	25	2
			50	2
Labetalol	3 (4.5)	Oral	2	2
			5	1
Hydrochlorothiazide	3 (4.5)	Oral	25	3
Aldactone	2 (3)	Oral	25	2
Hydralazine	1 (1.5)	Oral	5	1

cardiac, vascular, and cerebral complications and mortality and stroke after one year of CEA (18). The most commonly used hypertensive medications were Nitroglycerin, Losartan, Amlodipine, Nitrocontin, and Lasix. This rate was 77.3%, 39.4%, 24.2%, 19.7% and 13.6%, respectively, which led to a decrease in blood pressure in patients and, as mentioned earlier, one of the complications of hypertension was surgery is carotid artery endarterectomy. Therefore, a rapid reduction of blood pressure during and after surgery; using blood pressure medicine reduces the complications of arterial endarterectomy (18, 21). In this study, 75.8% of patients were overweight, and obese (more than 25%) and only 24.2% of patients had a normal weight (18.5-25). Also, other studies found similar results. Gassner et al., Michigan, reported that 69.6% of patients were overweight (22), which is consistent with the present study. According to other studies, obesity and overweight as a chronic disease increase the risk of mortality and many chronic diseases such as diabetes type 2, hypertension and dyslipidemia and coronary artery disease. Obesity will increase the risk of cardiovascular disease and type 2 diabetes and will act as an independent factor for overall cardiovascular mortality (23). According to the results, only three patients had endotracheal intubation in the ICU after surgery; all of them were over 70 years of age. Also, all three patients had surgery on the left

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side. Infection and mortality depend on the hospital facilities and the number of surgeries performed. The most important thing is that all surgeons must record and check the surgical results to ensure the quality of surgery at their center (24). In the present study, 64 patients (64%) had at least one underlying disease. Among the underlying diseases, hypertension (83.3%), stroke (66.7%) and hyperlipidemia (66.7%) were the most prevalent, which is consistent with other studies. For example, Gibbs studied in the United States and showed that 82.9% of patients with hypertension (HTN), 55.4 with CVA, 70.7% had hyperlipidemia (HLP) and 42.4% had diabetes which is consistent with the present study (17). One of the major risk factors of stroke is carotid artery stenosis, and patients with vascular problems and some underlying diseases such as diabetes, hypertension, smoking, and hyperlipidemia are more likely to develop carotid artery atherosclerosis (25). In this study, it was found that more than half of the subjects were men, 66.7% of patients being men and 33.3% women. Bouri et al., at the study, which was a collection of 36 studies performed from 1963 to 2010, reported that 63% of patients were men, and 37% were women (26). In this study, 27 right-sided carotid patients and 39 patients left carotid arteries were identified. Hemati et al. reported that 51 patients underwent carotid artery endarterectomy at Razi Hospital in Rasht, with 25 left carotid and 26 right carotids (24). That study is consistent with the present based on the results. The changes in body temperature, heart rate and systolic blood pressure at the time of measurement (6, 12, 18, 24, 36 and 48 hours after surgery) were statistically significant and increased. However, there was no significant difference in diastolic blood pressure and mean arterial blood pressure in patients with carotid endarterectomy and no significant change. In this study, the duration of hospitalization and ICU in carotid artery endarterectomy patients was 3.89±3.53 and 6.79±4.55 days, respectively, which is consistent with other similar studies (18, 27-29).

Conclusion

According to the results of this study, blood pressure control in patients with blood pressure changes during and after surgery; reduces hemodynamic changes after endarterectomy. Therefore, recognition of these factors can lead to prognosis leading to hemodynamic control and stabilization of blood pressure during and after surgery; and necessary measures to improve blood pressure control in these patients. To the best of our knowledge, this is the first report that is investigating the hemodynamic changes in patients with carotid stenosis undergoing carotid endarterectomy in Guilan province. The limitations of this study were included incomplete patient records, which were excluded from the study.

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Conflicts of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Authors' contributions

Study design: H.H., S.S., Z.J., M.F.
Writing: S.A., C.EA., S.R., and E.R.
Final revision: All authors

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Table 4. Hemodynamic changes in patients undergoing carotid endarterectomy (n = 66)

Timing of the measurement	Number	Moderate (minimum-maximum)		P-value
Before surgery	66	37/00 (36/37-50/70)	36/0±98/18	
6 hours after surgery	66	36/90 (36/37-00/60)	36/0±82/37	
12 hours after surgery	66	37/00 (36/37-00/00)	36/0±95/32	
18 hours after surgery	66	37/20 (36/37-00/00)	37/0±16/34	<0.001
24 hours after surgery	63	37/00 (36/38-20/00)	37/0±08/38	
36 hours after surgery	54	37/05 (36/38-50/00)	37/0±13/39	
48 hours after surgery	36	37/20 (36/37-50/80)	37/0±09/37	
Before surgery	66	79/00 (54/92-00/00)	78/5±70/10	
6 hours after surgery	66	80/50 (56/129-00/00)	79/13±89/89	
12 hours after surgery	66	78/50 (53/108-00/00)	80/12±35/77	
18 hours after surgery	66	79/00 (54/108-00/00)	79/11±38/43	0.001
24 hours after surgery	63	77/00 (57/107-00/00)	76/10±87/18	
36 hours after surgery	54	75/00 (46/103-00/00)	75/11±31/63	
48 hours after surgery	36	78/50 (60/118-00/00)	80/12±78/20	
Before surgery	66	120/00 (110/180-00/00)	119/11±89/89	
6 hours after surgery	66	135/00 (102/170-00/00)	135/15±36/72	
12 hours after surgery	66	139/50 (100/165-00/00)	136/14±70/42	
18 hours after surgery	66	140/00 (30/164-00/00)	136/18±03/76	<0.001
24 hours after surgery	63	140/00 (110/172-00/00)	137/13±79/74	
36 hours after surgery	54	139/00 (106/165-00/00)	135/14±33/02	
48 hours after surgery	36	140/50 (95/170-00/00)	138/16±89/66	
Before surgery	66	80/00 (70/90-00/00)	76/5±51/69	
6 hours after surgery	66	74/50 (58/105-00/00)	75/10±39/91	
12 hours after surgery	66	73/00 (55/107-00/00)	74/11±03/24	
18 hours after surgery	66	72/50 (52/95-00/00)	74/9±61/83	0.461
24 hours after surgery	63	75/00 (59/98-00/00)	76/9±71/54	
36 hours after surgery	54	76/00 (52/98-00/00)	76/10±07/11	
48 hours after surgery	36	74/50 (60/109-00/00)	74/9±97/48	
Before surgery	66	93/00 (83/113-00/00)	90/6±61/80	
6 hours after surgery	66	94/00 (75/121-00/00)	95/10±01/88	
12 hours after surgery	66	94/50 (72/122-00/00)	94/10±50/66	
18 hours after surgery	66	96/00 (71/116-00/00)	95/9±15/57	0.136
24 hours after surgery	63	95/00 (77/116-00/00)	96/9±75/79	
36 hours after surgery	54	96/00 (72/119-00/00)	95/10±44/56	
48 hours after surgery	36	95/50 (75/119-00/00)	96/9±11/58	
Before surgery	61	37/00 (36/37-50/70)	36/0±97/19	
6 hours after surgery	61	36/80 (36/37-00/60)	36/0±80/38	
12 hours after surgery	61	37/00 (36/37-00/70)	36/0±95/31	
18 hours after surgery	61	37/20 (36/37-00/80)	37/0±16/34	<0.001
24 hours after surgery	59	37/00 (36/38-20/00)	37/0±07/37	
36 hours after surgery	50	37/00 (36/38-50/00)	37/0±12/39	
48 hours after surgery	35	37/20 (36/37-50/80)	37/0±07/37	
Before surgery	61	78/00 (54/92-00/00)	78/5±70/27	
6 hours after surgery	61	81/00 (56/129-00/00)	80/14±15/14	
12 hours after surgery	61	79/00 (53/108-00/00)	80/12±56/89	
18 hours after surgery	61	80/00 (54/108-00/00)	79/11±79/76	0.005
24 hours after surgery	59	77/00 (57/107-00/00)	76/10±91/52	
36 hours after surgery	50	74/50 (46/103-00/00)	75/12±30/00	
48 hours after surgery	35	78/00 (60/118-00/00)	80/12±69/36	

Next page

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(Continue) Table 4. Hemodynamic changes in patients undergoing carotid endarterectomy (n = 66)

Timing of the measurement	Number	Moderate (minimum-maximum)		P-value
Before surgery	61	120/00 (110/180-00/00)	120/12±41/16	
6 hours after surgery	61	135/00 (103/170-00/00)	136/15±46/31	
12 hours after surgery	61	140/00 (100/165-00/00)	137/13±46/91	
18 hours after surgery	61	140/00 (30/164-00/00)	136/18±64/99	<0.001
24 hours after surgery	59	140/00 (110/172-00/00)	138/13±36/73	
36 hours after surgery	50	140/00 (106/165-00/00)	135/14±74/32	
48 hours after surgery	35	141/00 (95/170-00/00)	139/15±83/91	
Before surgery	61	80/00 (70/90-00/00)	76/5±72/70	
6 hours after surgery	61	74/00 (58/105-00/00)	75/10±00/99	
12 hours after surgery	61	73/00 (55/107-00/00)	73/11±77/39	
18 hours after surgery	61	73/00 (52/95-00/00)	74/10±90/11	0.324
24 hours after surgery	59	75/00 (59/98-00/00)	76/9±90/83	
36 hours after surgery	50	76/00 (52/98-00/00)	76/10±14/48	
48 hours after surgery	35	74/00 (60/109-00/00)	74/9±83/58	

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