SÃO PAULO MEDICAL JOURNAL

ORIGINAL ARTICLE

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Supraceliac Clamping in The Surgical Treatment of Abdominal Aortic Aneurysm. An Experimental Study in Dogs

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Previous reports have suggested the use of supraceliac aortic clamping in the surgical treatment of abdominal aortic aneurysm of difficult approach. The objective of the present report was to study the hepatic and renal metabolic changes of three groups of dogs submitted to temporary clamping (30 minutes) of the abdominal aorta at three different levels: below the renal arteries, infrarenal group (8 dogs); above the renal arteries, suprarenal group (9 dogs); above the celiac artery, supraceliac group (9 dogs). Blood bilirubin, alanine aminotransferase (ALT), aspartate aminotransferase (AST), urea nitrogen, and creatinine levels were measured before clamping and 5 minutes and 24 hours after reperfusion of the aorta. Bilirubin levels remained unchanged 5 minutes and 24 hours after reperfusion in all three groups. Alkaline phosphatase levels were significantly increased in all three groups 24 hours after reperfusion. ALT levels increased significantly in the supraceliac group and AST levels increased significantly in the infrarenal and supraceliac groups 24 hours after reperfusion of the aorta. However, despite these significant increases after reperfusion, the levels of these hepatic enzymes were still within the normal range for dogs. Urea nitrogen and creatinine levels showed that renal function did not change in any of the three groups. We conclude that supraceliac, infrarenal or suprarenal aortic clamping for 30 minutes do not promote any important changes in the hepatic or renal function of dogs.

UNITERMS: Aneurysms, surgery; ischemia, surgery; reperfusion injury.

INTRODUCTION

Elective surgery for infrarenal abdominal aortic aneurysm presents a 2 to 6% rate of postoperative mortality (2,4,8,9,13). This relatively low rate is partly due to improvement of preoperative evaluation, of the anesthetic care and of the treatment of associated problems. However, surgical risks may be increased by technical difficulties in aneurysm repair. Difficulties in the dissection and clamping of the proximal colon of infrarenal aneurysms (inflammatory aneurysms, juxtarenal aneurysms, and false aneurysms) may cause damage to the duodenum and renal arteries, and microembolism of atheroma plaques, thus increasing operative morbidity and mortality.

To prevent these risks, some investigators have proposed supraceliac aortic clamping for the treatment of aneurysms of difficult approach (3,7). Green et al (7) observed that supraceliac vascular clamping presents lower morbidity and mortality rates than clamping immediately above the renal arteries and similar rates when the infrarenal aorta is clamped. Supraceliac aortic clamping causes a

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transitory ischemia of all organs in the abdominal cavity and of the lower limbs.

To determine the possible hepatic and renal metabolic effects of the procedure, we submitted three groups of dogs to transitory abdominal aortic clamping (30 minutes) at the infrarenal level, immediately above the renal arteries, and at the supraceliac level, respectively.

MATERIALS AND METHODS

Twenty-six mongrel dogs of both sexes were divided at random into 3 groups, each submitted to abdominal aortic clamping at a different level: infrarenal (8 dogs), suprarenal (9 dogs), and supraceliac (9 dogs).

All animals were submitted to general anesthesia with Nembutal (50 mg/kg) and intubated and ventilated with a Takaoka respirator throughout the experiment. Physiological glucose was administered intravenously at the rate of 8 ml/kg/h to maintain hydration.

The animals were laparotomized through a median incision and the abdominal aorta was exposed by careful dissection. The aorta was clamped with a bull-dog vascular clamp at the three different levels indicated above: infrarenal (immediately below the renal arteries), suprarenal (above the renal arteries and below the mesenteric artery), and supraceliac (above the celiac trunk). The duration of occlusion was 30 minutes for all groups.

Heparin (2 mg/kg, Liquemine, Roche) was administered 5 minutes before aortic clamping to prevent arterial thrombosis distal to the vascular clamp.

Mean animal weight was similar in all groups: infrarenal, 11.5±3.37 kg (8); suprarenal, 10.1 ± 2.49 kg (9); supraceliac, 11.2 ± 3.80 kg (9).

Blood samples (5 ml) were obtained from each animal before aortic clamping and 5 minutes and 24 hours after reperfusion. The sera obtained from these samples were used for measurement of some parameters of hepatic function (transaminases, bilirubins and phosphatases) and renal function (creatinine and urea). Bilirubins were measured by the method of Sims-Horn and the enzymes (alanine aminotransferase and aspartate aminotransferase) by the method of Reitman and Frankel (17) (14). Alkaline phosphatase was measured by the method of Roy, modified (16). Urea was measured by the diacetyl method, modified, and creatinine by the Sustosa-Basques method.

Data were analyzed statistically by the Friedman test for intragroup comparisons and by the Kruskal-Wallis test for intergroup comparisons, with the level of significance set at 5%.

RESULTS

Parameters for hepatic evaluation - The median concentrations of total and direct bilirubins for the three groups of dogs are presented in Table 1. It can be seen that there were no changes in median total or direct bilirubin concentrations in any of the three experimental groups.

TABLE 1

Median, maximum and minimum values of total (T) and direct (D) bilirubins (mg/dl) in dogs submitted to abdominal aortic clamping at different levels, determined before clamping, and 5 minutes (min) and 24 hours (h) after reperfusion.

		LEVEL					
TIME		INFRARENAL		SUPRARENAL		SUPRACELIAC	
		T	D	T	D	T	D
Befor clamping	M	0.35	0.23	0.35	0.10	0.30	0.20
	V	0.50	0.40	0.60	0.20	0.50	0.30
	v	0.01	00.1	0.10	00.5	00.1	0.00
5min.	M	0.38	0.13	0.40	0.10	0.40	0.10
	V	0.60	0.25	0.80	0.30	0.60	0.30
	v	0.01	0.00	0.20	0.05	0.01	0.00
Reperfusion 24h	M	0.45	0.45	0.40	0.10	0.40	0.20
	V	0.70	0.30	1.00	0.25	0.90	0.35
	v	0.01	0.00	0.20	0.10	0.10	0.04

M= median; V = maximum value;v=minimum value

The median alkaline phosphatase concentrations for the three groups are presented in Table 2.

No changes in alkaline phosphatase levels were observed 5 minutes after reperfusion in any of the three groups, whereas a significant increase occurred in all groups 24 hours after reperfusion in relation to preclamping values and to 5 minutes post-reperfusion. Considering that the normal range for alkaline phosphatase levels in dogs is 10-92 IU/l (10), it can be seen that the levels observed in the three groups were distributed homogeneously, with a tendency toward elevation but with no significant differences between them (Fig. 1).

ALT levels are presented in Table 3. No changes in ALT levels occurred in the infrarenal and suprarenal groups after reperfusion, but a tendency toward an increase in ALT levels was observed in the supraceliac group

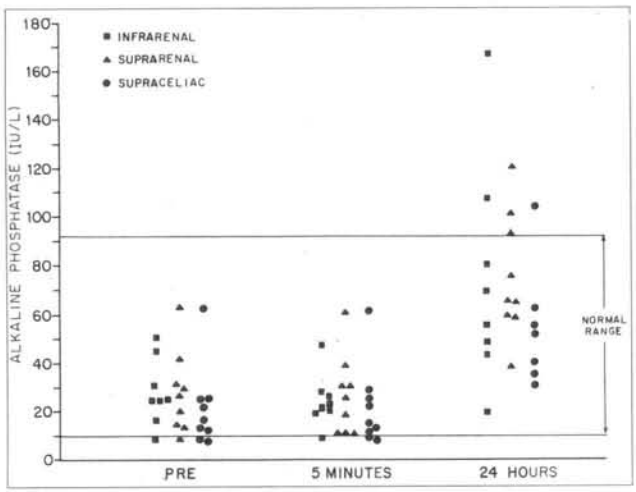

Fig. 1 - Distribution of alkaline phosphatase levels observed before clamping and 5 minutes and 24 hours after reperfusion of the infrarenal, suprarenal and supraceliac abdominal aorta.

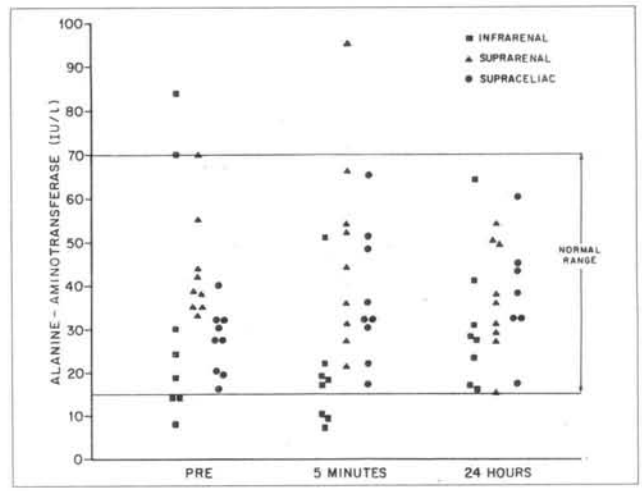

Fig. 2 - Distribution of alanine aminotransferase (ALT) levels observed before clamping and 5 minutes and 24 hours after reperfusion of the infrarenal, suprarenal and supraceliac abdominal aorta.

TABLE 2

Median, maximum and minimum values of alkaline phosphatase (IU/l) in dogs submitted to abdominal aortic clamping at different levels, determined before clamping, and 5 minutes (min) and 24 hours (h) after reperfusion

		LEVEL		
TIME		INFRARENAL	SUPRARENAL	SUPRACELIAC
Before clamping	M	25	26	16
	V	51	62	62
	v	09	09	08
5 min	M	22	25	15
	V	47	61	61
	v	09	10	08
Reperfusion				
24 h	M	62*	65*	52*
	V	167	120	104
	v	20	38	31

M = median; V= maximum value; v = minimum value P<0.05 (comparison between preclamping values and values obtained 5 minutes after reperfusion).

TABLE 3

Median, maximum and minimum values of alanine aminotransferase (ALT) and aspartate aminotransferase (AST) (IU/l) in dogs submitted to abdominal aortic clamping at different levels, determined before clamping, and 5 minutes (min) and 24 hours (h) after reperfusion

		LEVEL					
TIME		INFRARENAL		SUPRARENAL		SUPRACELIAC	
		ALT	AST	ALT	AST	ALT	AST
Before clamping	M	24	12	39	30	27	19
	V	84	57	70	55	40	25
	v	08	03	33	16	16	12
5 min.	M	17.5	13	44	27	32	28
	V	51	57	95	72	65	43
	v	07	08	21	10	17	14
Reperfusion							
24 h	M	27.5	23.5	36	31	38**	23+
	V	64	70	54	51	60	69
	v	16	06	15	16	17	17

M = median; V = maximum value; v = minimum value *P<0.05 (comparison between preclamping values and values obtained 5 minutes after reperfusion).
**,+P<0.05 (comparison between preclamping values and values obtained 5 minutes and 24 hours after reperfusion).

5 minutes after reperfusion, with the differences becoming significant 24 hours after reperfusion as compared to initial values.

Virtually all values detected 5 minutes and 24 hours after reperfusion were withing the normal range for dogs (15 to 70 IU/I)(10) in all three groups (Fig.2.)

AST levels are presented in Table 3. In the infrarenal group there was a significant increase in AST

levels 24 hours after reperfusion in relation to the preclamping values and to the values obtained 5 minutes after reperfusion. All the values observed during the post-perfusion period in all three groups were within the normal range for AST in dogs, 13 to 93 IU/l (10).

Renal function parameters- Urea and creatinine levels for the three groups studies are presented in Table

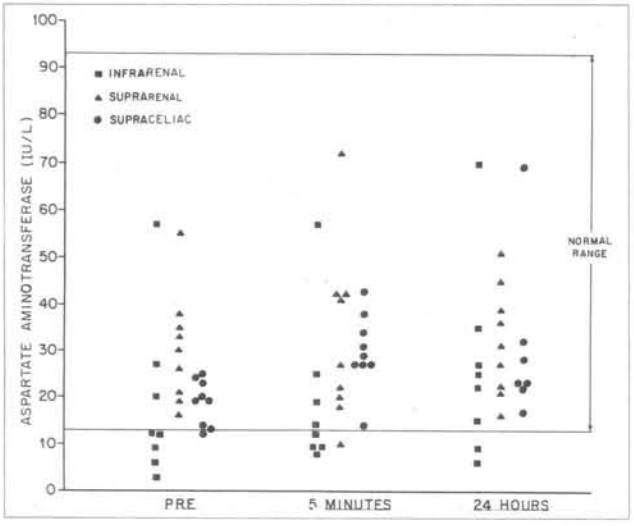

Fig. 3 - Distribution of aspartate aminotransferase (AST) levels observed before clamping and 5 minutes and 24 hours after reperfusion of the infrarenal, suprarenal and supraceliac abdominal aorta.

4. No changes in urea or creatinine levels were observed in any of the three groups 5 minutes or 24 hours after reperfusion.

DISCUSSION

Surgery of the abdominal aorta implies the use of vascular clamping for the treatment of degenerative diseases such as aneurysms and obstructions, and of traumatic injuries. Vascular clamping is not free of complications. When the infrarenal abdominal aorta is clamped, a rapid elevation in systemic arterial pressure often occurs, with hemodynamic consequences for the heart, kidneys and brain, as well as ischemia of lower limbs. Abdominal aortic clamping above the renal arteries or the celiac trunk rapidly affects arterial flow in the former case and perfusion of kidneys and remaining intra-abdominal organs in the latter.

Surgery of infrarenal abdominal aortic aneurysm implies aortic clamping immediately below the renal arteries, but in cases of aneurysms of difficult approach (infected aneurysm, false aneurysm etc.), aortic clamping above the

TABLE 4
Median, maximum and minimum values of urea (U) and creatinine (Cr) (mg/dl) in dogs submitted to abdominal aortic clamping at different levels, determined before clamping, and 5 minutes (min) and 24 hours (h) after reperfusion

		LEVEL					
TIME		INFRARENAL		SUPRARENAL		SUPRACELIAC	
		U	Cr	U	Cr	U	Cr
Before clamping	M	35.5	0.65	27	0.80	32	0.90
	V	74	0.90	37	1.10	63	1.20
	v	15	0.40	33	0.40	21	0.50
5 min.	M	39	0.60	30	0.80	36	1.00
	V	74	1.00	41	1.20	62	1.30
	v	20	0.50	17	0.40	27	0.80
Reperfusion 24 h	M	36	0.50	26	0.80	29	0.80
	V	77	0.80	61	1.00	79	1.30
	v	23	0.30	17	0.50	21	0.60

M = median; V = maximum value; v = minimum value

celiac trunk is recommended to facilitate the procedure (3,7). Veith et al (18) have also used supraceliac aortic clamping in the surgical treatment of fissured or ruptured abdominal aortic aneurysms because this procedure permits easy and rapid isolation of the aorta. Green et al (7) observed that supraceliac clamping presents a lower rate of operative morbidity and mortality when compared to infrarenal aortic clamping in the treatment of abdominal aortic aneurysm.

In the present study, we investigated the possible biochemical changes in hepatic and renal functions occurring after aortic clamping at three different levels: infrarenal, suprarenal and supraceliac. Regarding hepatic function, direct and total bilirubin were unchanged at 5 minutes and 24 hours after reperfusion at all three levels of aortic clamping. However, a significant increase in alkaline phosphatase was observed in all three groups 24 hours after reperfusion of the abdominal aorta. This increase did not exceed the range of alkaline phosphatase values observed before aortic clamping or the range considered to be normal for dogs.

Alkaline phosphatase is primarity derived from the liver and bone and, in smaller amounts, from the intestinal tract and its elevation is usually due to cholestatic disorders (12,15). Since in the present study there were no signs of hepatic cholestasis, as indicated by the unchanged bilirubin levels, the increase in alkaline phosphatase detected in the three groups of animals was probably due to production of the enzyme by bone and by the intestinal tract during the study period. Green et al. (7) did not detect changes in

bilirubins or alkaline phosphatase in humans after reperfusion of the supraceliac aorta. These investigators, however, did not report how long after reperfusion they measured bilirubin and phosphatase levels.

We observed a significant increase in ALT 24 hours after aortic reperfusion in relation to initial values in the supraceliac group, but no changes in the other two groups. In the supraceliac group there was hepatic ischemia for a utes, whereas in the other two groups hepatic perfusion was maintained. ALT and AST are sensitive indicators of hepatic ischemia (5,6,19,20) and are particularly useful in the diagnosis of acute hepatocellular diseases (12). The elevation in AST was also observed in the supraceliac and infrarenal groups 24 hours after aortic reperfusion, a fact that did not occur in the suprarenal group. All the AST values detected in all groups after aortic reperfusion were within the normal range for dogs.

Because of the hepatic ischemia provoked by abdominal aortic clamping above the celiac trunk, we expected changes in ALT and AST levels. The significant increase in AST in the infrarenal group 24 hours after reperfusion is paradoxical and is not justified by hepatic ischemia since there was no change in liver perfusion.

The causative factor of this increase in AST in the infrarenal group should also have been present in the suprarenal group since hepatic perfusion was also maintained in the latter. Overall, the changes in AST and ALT, although significant, did not exceed the values considered to be normal for dogs; thus, these changes, from a biological viewpoint, must not be important, at least during the 30-minute period of abdominal aortic clamping and during the 24-hour period of observation.

Normal biochemical values are also known to vary in dogs depending on gender, kind, age and laboratory (10). All the animals used in the present study were mongrel dogs but it was impossible to determine their age and gender was not specified for the study, a fact that might account for the variability detected in the pre-and post-aortic clamping phases in the three groups of dogs.

Green et al (7) have reported increased AST levels in patients submitted to supraceliac clamping, but without any clinical manifestations. These investigators did not report the duration of aortic clamping.

Renal function evaluated by creatinine and urea rates was unchanged in the three groups of animals regardless of level of abdominal aortic clamping at 5 minutes and 24 hours after reperfusion. In contrast, data about humans show the onset of renal insufficiency and increased creatinine and urea rates after suprarenal clamping as compared to infrarenal and supraceliac clamping (7). Some investigators believe that aortic clamping above or below the renal arteries in atherosclerotic patients provokes embolism of the kidneys due to detachment of atherosclerotic material close to the clamp. This mechanism was not observed in the present study, since there were no atherosclerotic lesions in the aorta of the animals under study.

We conclude that supraceliac abdominal aortic clamping for 30 minutes does not provoke important changes in hepatic or renal function in dogs when compared to infra- and suprarenal aortic clamping. Thus, the present data confirm those obtained for humans, which indicate that supraceliac clamping should be used in the treatment of infrarenal abdominal aortic aneurysms of difficult proximal approach both in elective and emergency surgeries.

ACKNOWLEDGMENTS

We are grateful to Laucéa Conrado Silva Porcincula, José Carlos Vanni, Sebastião Assis Mazzetto and Paulo Alves Junior for their technical assistance.

This study was supported by CNPQ - grants 301 788185

REFERENCES

1. COHEN, J.R.; MANNICK, W.C.; COUCH, N.P. & WHITTEMORE, A.D.:Abdominal aortic aneurysm repair in patients with preoperative renal failure. **J. Vasc. Surg, 3:** 867-870, 1986.
2. CRAWFORD, E.S.; SALEH, S.A.; BABB, J.M.III.; GLAESER, D.H.I.; VACCARO, P.S. & SILVERS, A: Infrarenal abdominal aortic aneurysm. Factors influencing survival after operation performed over a 25 year period. **Ann Surg, 133:** 699-709. 1981.
3. CRAWFORD, E. S. ; BECKETT, W. C. & GREER, M. S. : Juxtarenal infrarenal abdominal aortic aneurysm. **Ann Surg, 203:** 661-670, 1986.
4. DARLING, R. R. & BREWTSTER, D.C.: Elective treatment of abdominal aortic aneurysm. **World J Surg, 4:** 661-667, 1980.
5. DE RITIS, F.; GIUSTI, G.; PICCININO, F. & CACCIATORE, L. : Biochemical lab tests in viral hepatic and other hepatic diseases. **Bull WHO 32:** 59-72, 1965.
6. ELLIS, G.; GOLDBERG, D. & SPOONER, F.M. : Serum enzyme tests in diseases of liver and biliary tree. **Am J Clin Pathol, 70:** 248-258, 1978.
7. GREEN, R.M., RICOTTA, J.J.; DURIEL, K. & DEWEESE, J.A.: Results of supraceliac aortic clamping in the difficult elective ressection of infra renal abdminal aortic aneurysm. **J Vasc Surg, 9:** 124-132, 1989.

8. HERTZEL, N.R.; AVELLONE,, J.C. & FARREL, C.J.: The risk of vascular surgery in a metropolitan community with observations on surgeon experience and hospital size. **J Vasc Surg, 1:** 13-21, 1984.
9. JOHNSTON, K.N. & SCOBIE, T.K.: Multicenter prospective study of nonruptured abdominal aortic aneurysms. Population and operation management. **J Vasc Surg, 7:** 69-81, 1988.
10. KIRK, R.W. Atualização terapêutica veterinária. Editora **Manole, São Paulo,** 1988, vol. 2/1
11. QVARFORDT, P.G.; STONEY, R.J.; REILLY, L.M.; SKIOLDEBRAND, C.G.; GOLDSTONE, J. & EHRENFELD, W. K. : Management of pararenal aneurysms of the abdominal aorta. **J Vasc Surg, 3:** 84-93, 1986.
12. REICHLING, J.J. & KAPLAN, M.M. Clinical use of serum enzymes in liver disease. **Dig Dis Sci, 33:** 1601-1614, 1988.
13. REIGEL, N.R.: Basic data concerning associated coronary disease in peripheral vascular. **Ann Vasc Surg,** 1: 616-620, 1988.
14. REITMAN, S. & FRANKE, S. : A calorimetric method for the determination of serum glutamic oxalacetic and glutamic pyruvic transaminase. **Am J Clin Pathol, 28:** 56-63, 1957.
15. ROBERTS, W.M. : Variations in the phosphatase activity in the blood in disease. **Br J Exp Pathol, 11:** 90-95, 1930.
16. ROY, A.V. : Rapid method for determining alkaline phosphatase activity in serum with thymolphythalein monophosphate. **Clin Chem, 16:** 431-436, 1970.
17. SIMS, F.H. & HORN, C. Some observations on Powell's methods for the determination of serum bilirrubin. **Am J Clin Pathol, 29:** 412-417, 1958.
18. VEITH, F.H.; GUPTA, S.K. & WENGERTER, K.R. : Emergency abdominal aortic aneurysm surgery and supracoeliac aortic control. In: **Greenhalgh, R.M. and Mannick, J.A. The cause and management of aneurysm.** 1st Ed., WB Saunders Co., London, 367-399, 1990.
19. WROBLESKI, F. : The clinical significance of transaminase activities in serum. **Am J Med, 27:** 911-932, 1959.
20. ZIMMERMANN, H.J. & WEST, M. : Serum enzyme levels in the diagnosis of hepatic disease. **Am J Gastroenterol, 40:** 387-404, 1963.

RESUMO

Trabalhos anteriores sugerem a oclusão supra-celíaca no tratamento cirúrgico dos aneurismas da aorta abdominal de difícil abordagem. Com o objetivo de estudar as repercussões metabólicas hepáticas e renais, três grupos de cães foram submetidos à oclusão temporária (30 minutos) da aorta abdominal em três níveis e designados: grupo infra-renal (8 cães) abaixo das artérias renais; grupo supra-renal (9 cães), acima das artérias renais e grupo supra-celíaco (9 cães), acima do tronco celíaco. Analisaram-se, no sangue, as bilirrubinas, a fosfatase alcalina, a alanina-amino-transferase (ALT), a aspartato-amino-transferase (AST), a uréia e a creatinina, antes da oclusão, 5 minutos e 24 horas após a reperfusão. As bilirrubinas não se alteraram 5 minutos e 24 horas após a reperfusão nos três níveis de oclusão. Houve aumento significativo da fosfatase alcalina nos três grupos de cães, 24 horas após a reperfusão. Observou-se aumento significativo da ALT no grupo supra-celíaco e de AST nos grupos infra-renal e supra-celíaco, 24 horas após a reperfusão. Apesar do encontro de alterações significativas destas enzimas hepáticas, após a reperfusão, seus valores distribuem-se na faixa considerada normal para o cão. Não houve alteração da função renal, com base nos dados de uréia e creatinina nos três grupos estudados. Conclui-se, que a oclusão da aorta abdominal supra-celíaca, durante 30 minutos, em cães, não provoca alterações importantes nas funções hepática e renal, comparativamente às oclusões da aorta infra e supra-renal.