

Nelson Wolosker, Paulo Celso Motta Guimarães, Alvaro Gaudêncio,  
Sérgio Kuzniec, Marcel Scheinman, Ricardo Aun, Berilo Langer.

## Trauma to arteries of the forearm

Work carried out at the "Hospital das Clínicas", Medical School of the São Paulo University, São Paulo.

Trauma to arteries of the forearm corresponds to 20% of total arterial trauma. The authors analyzed 24 patients with non iatrogenic trauma of the forearm arteries, cared for from January 1987 to December 1990.

All patients were male, trauma by penetrating instrument was the most frequent, with 21 cases (87.5%), absence of pulses was the most frequent clinical manifestation (62.5%), fifteen patients did not present ischemic manifestations (54.2%) and half of the patients did not exhibit neurological symptoms. Injury to only one artery was found in 11 cases, five of them in the radial artery (20.8%), five in the ulnar artery (20.8%) and one in the interosseous artery (4.2%). Concurrent injury to the radial and ulnar arteries was found in 13 cases (54.1%). Regarding nervous impairment, injury to the radial nerve was found in four cases (16.6%) and of the median and ulnar nerves, one case in each (4.1%).

All patients with concurrent injury to the ulnar and radial arteries (13) were submitted to arterial restoration. The 11 patients with injury to a sole artery of the forearm were managed as follows: ligature of the interosseous artery in one case, ligature of the radial artery in four cases, raphe of the radial artery in one case, ligature of the ulnar artery in three cases, restoration of the ulnar artery using a segment of the v. saphena in the two cases in which the Allen test had been positive.

One patient died in the immediate postoperative period as a result of multiple organ failure due to polytraumatism. Preservation of the member was attained in 23 patients (95.8%) and the sole amputation, was due to extensive traumatism of the soft tissues with severe infection and systemic impairment.

**UNITERMS:** Ulnar artery, radial artery, vascular surgery, wounds and injuries, trauma.

**T**rauma of the forearm arteries corresponds to 20% of all arterial trauma and up to 40% of these, when restricted to the upper member(5). Initially trauma might not be perceived because most patients do not exhibit signs of ischemia (10).

As ligature of the radial and ulnar arteries, frequently, has no significant aftermaths, literature on the subject is scarce (9).

In this study we propose to analyze trauma to the forearm arteries, in Brazil, where primary agent is caused by perforating injuries (due to cutting instruments, cold steel or glass), resulting in a peculiar statistic on surgical procedure and evolution at postoperative stage.

---

**Address for correspondence:** Dr. Nelson Wolosker  
R. Espéria, 30 - CEP-01433-060, São Paulo- Brazil

---

### CASUISTRY

---

Twenty four patients with non iatrogenic trauma of the forearm arteries were treated, admitted at the Emergency Ward of the "Hospital das Clínicas" (General Hospital) of the Medical School of São Paulo University, between January 1987 and December 1990.

Age ranged from 5 to 42 years, with a mean of 26 years, all were males. Sixteen patients (66.7%) were white and eight negroes (33.3%).

Trauma by penetrating instrument was the most frequent, 21 cases (87.5%), 17 (70.8%) caused by cutting instruments and four by firearm wounds. Closed trauma was found in three cases (12.5%), all associated to fracture of the forearm bones.

Clinical manifestations caused by arterial injury are detailed on Table I, absent pulses being the most frequent one. Reduction of perfusion or of temperature in the in-

jured member was considered as mild ischemia, and the presence, besides the above manifestations, of motor or sensorial disorders in the injured member, was considered severe ischemia.

Table 2 shows the distribution of patients according to the level of ischemia.

Distribution of patients according to neurological manifestations is reported on Table 3. Four of the patients

were not evaluated because they were in a state of coma, as result of cranio-encephalic trauma or of intoxication by an exogenous agent.

At clinical examination, feeling of pulses in the injured member was normal in 8 cases (33.3%). Absence of pulses, from the brachial down was found in 2 (8.3%), radial pulse was absent in 2 (8.3%), and in 2 others, ulnar pulse was absent. (8.3%) and both pulses absent, radial and ulnar, in 9 cases (37.5%). Evaluation of one patient could not be performed due to hemodynamic fluctuation.

Prior to surgery only one patient, a victim of multiple penetrating trauma, was submitted to arteriography.

Intra-surgical examination, elicited isolated injury of one artery in 11 cases, five to the radial artery (20.8%) five to the ulnar artery (20.8%) and one to the interosseous artery (4.1%). A simultaneous injury of the radial and ulnar arteries was perceived in 13 cases (54.1%). Regarding nerve impairment, injury to the radial nerve was found in 4 cases (16.6%) and one case of each, to the median and ulnar nerves (4.1%).

**Table 1**

**Distribution according to clinical manifestations**

Clinical Symptoms	Patients n=24	
	N	%
Absence of pulses	15	62.5
Ischemia of member	11	45.8
Bleeding	5	20.8
False aneurysm	5	20.8
Hematoma	1	4.1

**Table 2**

**Distribution according to level of Ischemia**

Level of ischemia	Patients n=24	
	N	%
Absence	13	54.2
Mild	6	25.0
Severe	4	16.6
No evaluation possible	1	4.2

**Table 3**

**Distribution according to neurologic manifestations**

Neurological manifestations	Patients n=24	
	N	%
Asymptomatic	12	50.0
Plegia	5	20.8
Paresthesia	3	12.5
Paresis	1	4.2
No evaluation possible	3	12.5

The right side was more often affected, in 16 opportunities (66.6%).

**SURGICAL PROCEDURES**

All patients with concurrent injuries to the arterial and ulnar arteries were submitted to arterial restoration. In eight of them the chosen procedure was restoration of the ulnar artery with a segment of the vena saphena magna, withdrawn on its distal portion, near the medial malleolus, with ligation of the radial. In two a bridge of both was performed. In two cases primary arterial anastomosis was performed, bilateral in one of them, and in the other, solely in the ulnar artery, because of the extensive injury

**Table 4**

**Surgical procedure carried out in relation to location of the Injury**

Artery	Nº	Uni-arterial graft	Bi-arterial graft	Raphe	Uniarterial anastomosis	Biarterial anastomosis	Ligature
Radial	5			1			4
Ulnar	5	2					3
Inter- osseous	1						1
Radial + Ulnar	13	8	2	1	1	1	
Total	24	10	2	2	1	1	8

to the radial artery. In the last case, suture of the ulnar artery could be instituted, ligature of the radial artery being the favored choice.

The 11 patients with isolated injury to one artery of the forearm, after the Allen test was undertaken, were treated as follows: ligature of the interosseous artery in one case, ligature of the radial artery in four cases, raphe of the radial artery in one case, ligature of the ulnar artery in three cases, restoration of the ulnar artery using a segment of the saphena in the two cases in which the Allen test had been positive.

Fasciotomy was used in five patients (20.8%) three with large wounds at the forearm and two with an over 24 hours ischemia, prior to vascular restoration.

## RESULTS

In the three patients who underwent a concurrent restoration of the two arteries (two with venous graft and one with primary end to end anastomosis), one restoration suffered thrombosis, while in the other, restoration continued to be functional.

One patient died in the immediate postoperative period because of multiple organ failure caused by polytraumatism.

Preservation of the member was attained in 23 patients (95.8%), the sole amputation was due to extensive trauma to the soft tissue with severe infection and systemic impairment. At hospital discharge, all patients presented good perfusion in the damaged extremity, however three patients (12.5%) presented some functional deficiency of the impaired member as a result of injury to peripheral nerve.

## DISCUSSION

Penetrating trauma by splinters, through impact against glass panes as well as through cutting instruments (knife and dagger) is, in literature, the main cause of traumatism to the forearm arteries, while trauma to the forearm arteries associated to bone fracture are less frequent (1). Most traumatisms reported in this paper were due to trauma by penetrating instruments.

Arterial trauma in the forearm is diagnosed at clinical examination. Because of the superficiality of these arteries, absence of pulses, ischemia, local bleeding and heart murmurs in arterial passages are much more evident.

It is noteworthy that given the profuse collateral circulation of the forearm, injury to one of the arteries seldom brings about ischemia of the hand. Nevertheless, in

about 20% of the anatomic parts incomplete arcus palmaris were found (3). That is why, application of the Allen test (7) is important, in which, should there be incomplete arcus palmaris, compression of one of the arteries at level of the radial face of the pulse, is associated to ischemia of the corresponding fingers.

Reports of the II World War experience, when arterial traumatism was treated solely by arterial ligation, relate a 5.1% rate of amputation in injuries to the radial artery, 1.5% for the ulnar artery and of 39% in case of concurrent injury (4). Should only one of the forearm arteries be injured, with no evidence of ischemia, it might be ligated with little risk of sequelae (9). Such was the approach used in 33% of patients in our casuistry.

In presence of ischemia or concurrent injury of the radial and ulnar arteries, arterial restoration must be performed. In three of the 11 cases with isolated arterial injury (radial, ulnar or interosseous) perfusion of the hand suffered alteration, therefore a graft with inverted saphena was performed in two of them and a lateral suture in the other. Of the 13 cases with injury to both arteries of the forearm, for ten of the cases restoration of only one of the arteries was undertaken. In the remaining three, restoration of both was carried out, as ischemia of the fingers persisted after repair of the first one.

As the ulnar artery is broader than the radial, it was favored for surgical restoration.

The only surrogate used for arterial grafts was autogenous vena saphena magna, notwithstanding the usage of synthetic prosthesis (6).

According to McCready, patients with injuries to the forearm arteries, seldom require fasciotomy, done by an extensive longitudinal incision in the flexor compartment, which can be extended through the carpal ligament until inside the hand (8). Only 20% of patients of this study required such procedure, data compatible with literature (8).

Lower rates of neurological injury than in other series were observed in the current casuistry. Only 25% of patients exhibited injury to peripheral nerve. In other care centers this rate can reach up to 76%. When analyzing the agents of trauma, a valid justification for such difference was found, as in the current series, 70% of injuries were caused by knife or dagger, while in literature, the most frequent cause is traumatism by splinters after impact against glass panes, producing extensive wounds (2).

## CONCLUSION

Patients with penetrating trauma to the forearm,

should, before suture of the superficial wounds is performed, undergo careful examination, with special attention given to signs of vascular injury. Diagnosis and early management not only result in a higher rate of preserved members, but also in a lower rate of functional deficiencies of the impaired member.

## REFERENCES

1. BERGAN, J. J.; CONN Jr., J. & TRIPPEL, O.H. – Severe ischemia of the hand. *Ann Surg*, 173: 301. 1971
2. BORMAN, K. R.; SNYDER, W. H. III & WERGELT, J. A. – Civilian arterial trauma of the upper extremity: An eleven year experience in 267 patients. *Am J Surg*, 148: 796. 1984.
3. COLEMAN, S. S. & ANSON, B. J. – Arterial patterns in the hand based upon a study of 650 specimens. *Surg Gynecol Obstet*, 113: 409, 1961
4. DeBAKEY, M. E. & SIMEONE, F. A. – Battle injuries of the arteries in World War II. *Ann Surg*, 123: 534, 1946.
5. DRAPANAS, T.; HEWITT, R. T.; WEICHERT, R. F. & SMITH, A. D. – Civilian vascular injuries: A critical appraisal of three decades of management. *Ann Surg*, 172: 351. 1970.
6. FELICIANO, D. V.; MATTOX, K. L. & GRAHAM, J. M. – Five year experience with PTFE grafts in vascular wounds. *J Trauma*, 25: 71, 1985.
7. GELBERMAN, R. H. & BLASINGAME, J. P. – The timed Allen test. *J Trauma*, 21: 477. 1981.
8. McCREADY, R. A. – Vascular trauma of upper extremity. *Surg Clin N Am*, 4: 755. 1988.
9. SITZMAN, J. V. & ERNST, C. B. – Management of arm arterial injuries. *Surgery*, 96: 896, 1984.
10. TOZZI, F. L.; AUN, R.; BECHARA, M. J.; WOLOSKER, N. & WAKSMAN, H. – Arteriografia em pacientes vítimas de trauma em trajeto vascular sem sinal clínico de lesão arterial. *Cir Vasc Ang*, 4: 19, 1988.

## RESUMO

O trauma de artérias do antebraço corresponde a 20% do total de traumas arteriais. Os autores analisaram 24 pacientes com trauma não iatrogênico de artérias do antebraço, atendidos de janeiro de 1987 a dezembro de 1990.

Todos os pacientes eram do sexo masculino, o trauma por agente penetrante foi o mais freqüente, com 21 casos (87,5%), a ausência de pulsos foi a manifestação clínica mais freqüente (62,5%), quinze pacientes não apresentavam manifestações isquêmicas (54,2%) e metade dos doentes eram assintomáticos do ponto de vista neurológico. Constatou-se lesão isolada de uma artéria em 11 casos, sendo cinco de artéria radial (20,8%), cinco de artéria ulnar (20,8%) e uma de artéria interóssea (4,2%). Lesão concomitante das artérias radial e ulnar foi verificada em 13 casos (54,1%). Quanto ao comprometimento nervoso, constatou-se lesão de nervo radial em 4 casos (16,6%) e de nervos mediano e ulnar em um caso cada (4,1%).

Todos os pacientes com lesão conjunta das artérias radial e ulnar (13) foram submetidos a restauração arterial. Os 11 pacientes com lesão isolada de uma artéria de antebraço foram tratados da seguinte maneira: ligadura de artéria interóssea em um caso, ligadura de artéria radial em quatro casos, rafia de artéria radial em um caso, ligadura de artéria ulnar em três casos, restauração de artéria ulnar com segmento de safena em dois casos nos quais o teste de Allen foi positivo.

Um paciente faleceu no pós-operatório imediato devido a falência de múltiplos órgãos por politraumatismo. A preservação do membro foi obtida em 23 doentes (95,8%) e a única amputação, se deveu a traumatismo de partes moles extenso com infecção grave e comprometimento sistêmico.