THE ROLE OF SIDE BRANCHES IN DETERMINING THE END POINT OF DAMAGE IN AVULSED ARTERIES: AN EXPERIMENTAL STUDY

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- Failure risk after replantation or revascularization of avulsion type of injuries is higher than other mechanical types.
- A few indirect methods have been suggested to determine the intact parts and suitability of the vessels for anastomosis such as the “red line” and “ribbon” signs.

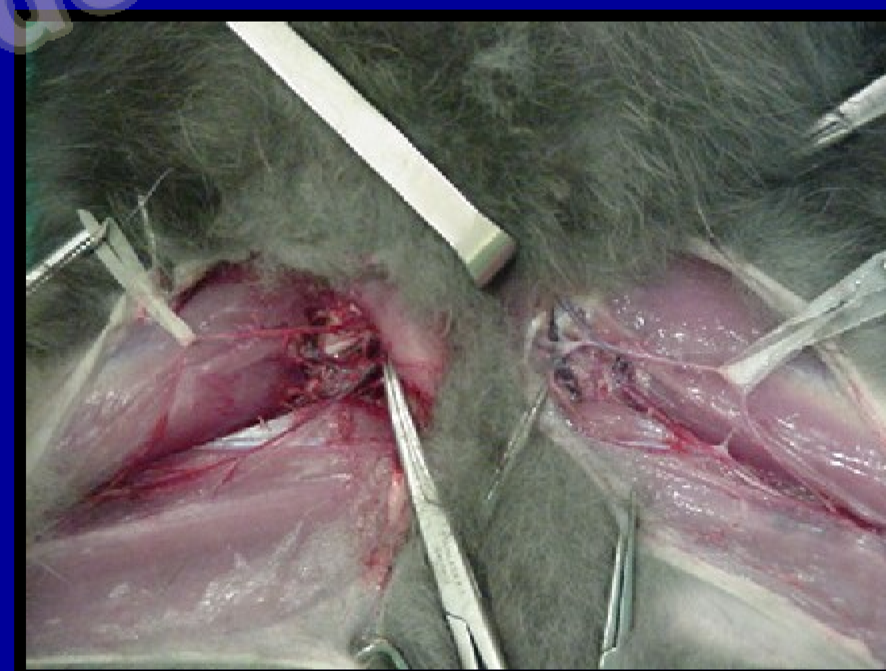
Red Line

The purpose of this experimental study:

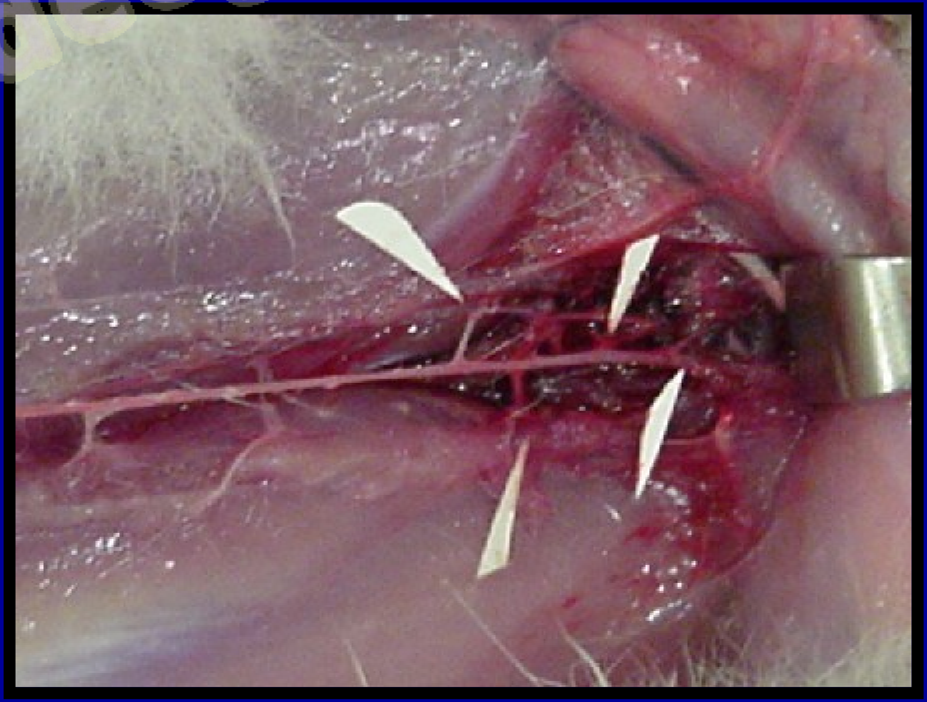
- To investigate the role of the arterial branches leaving the parent trunk in determining the localization of the intimal damage after an avulsion type of injury.
- We explored if the location and branching pattern of the side branches would be an indirect measure for the determination of the level of the avulsed artery, suitable for repair.

An operation and traction system for the avulsion model was prepared to employ a controlled longitudinal traction to femoral arteries of rabbits to create an avulsion type of injury.

- Ten New Zealand rabbits were placed under general anaesthesia by intraperitoneal injection of 0.5 ml (50 mg/ml) ketamine.
- The lower abdomen, both groin areas and medial thighs of each animal were cleaned.
- A long incision was made along the abdominal midline and extended along the medial thigh to the knee on both legs.
- The femoral vein, artery and nerve were exposed from the inguinal ligament to the saphenous bifurcation along the incisions on each side.
- The surrounding connective tissue of the vessels was removed in both legs.



- The side branches of the femoral artery were ***protected*** at the ***left*** legs.
- While all of the side branches were ***ligated and cut*** at the ***right*** legs.
- The saphenous and popliteal arterial bifurcations were kept intact at each side with their surrounding connective tissue and side branches to ensure an ***equal and consisted*** traction mechanism.

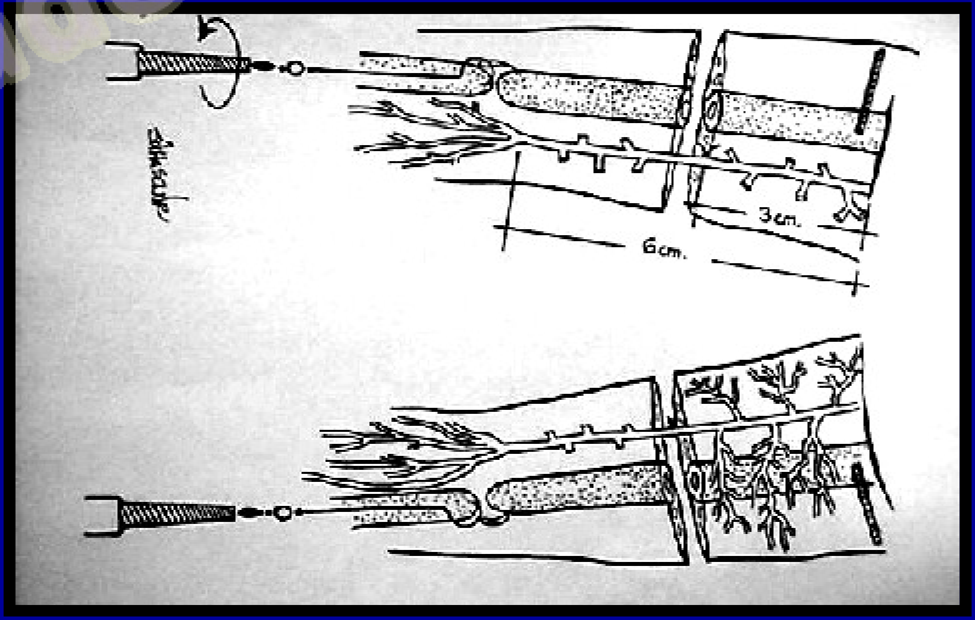


- The animals were sacrificed with an overdose of intraperitoneal sodium thio-penthal immediately after this operation.
- The femoral nerves and veins were removed.
- Both femora were stabilized at the trocanteric region by vertical K-wires of 1.5-mm of diameters onto the table of the system.

•A hook-shaped 1.2-mm diameter of K-wire was passed through the patellar tendon at its insertion to tuberositas tibia and extended distally over a screwed system on both sides.
•A swivel was applied to the tip of the screw to prevent rotation of the wires during traction.
•A controlled longitudinal traction was applied on both legs and the wires were stretched

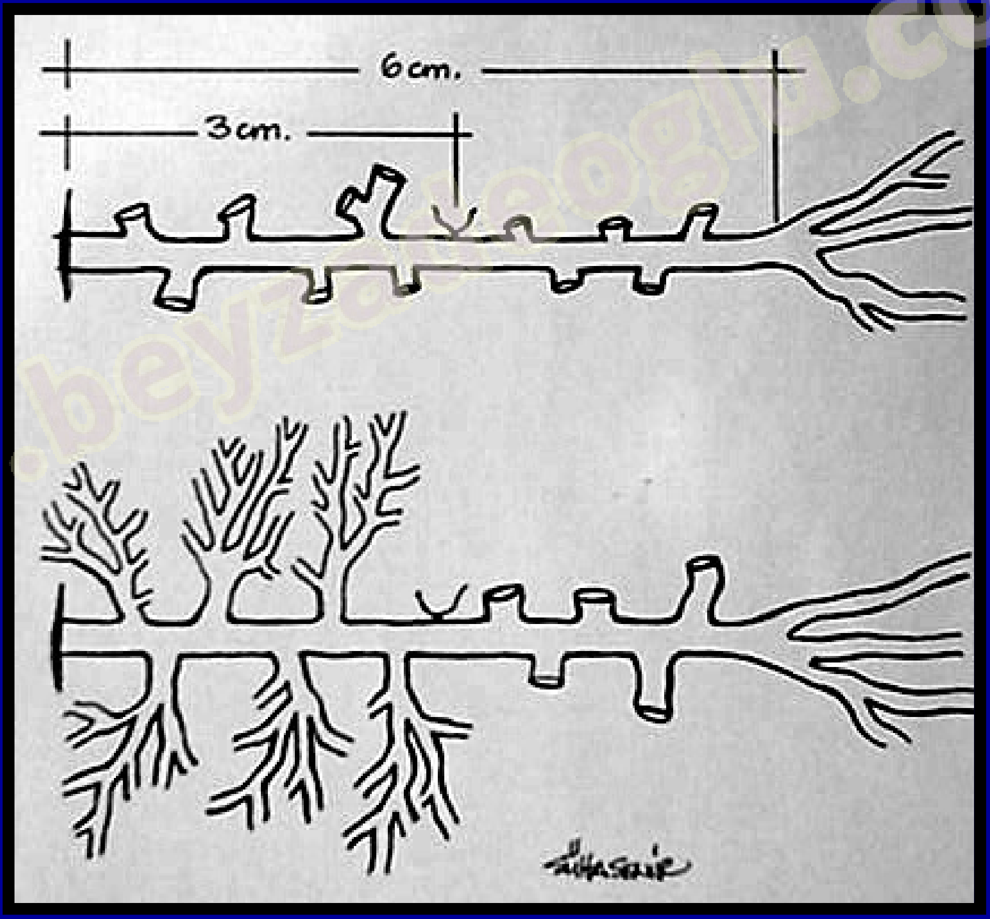
- The distance between the inguinal ligament and popliteal bifurcation was measured and the mid-point of this distance was marked with 6/0 nylon suture passing through the adventitia without any damage to the intima and media layers.
- The distance between the inguinal ligament and the marked suture was measured and recorded before traction while the vessels were in their original lengths because of the skeletal support.

•The soft tissue and the femora were then divided at the level of the marked suture circumferentially by sharp dissection and bone cutters. The femoral arteries were kept intact with and without side branches at left and right legs, respectively, and a ***controlled longitudinal traction*** was applied by turning the screw.



- During traction, ***at every tour of the screw, the elongation of the artery between the inguinal ligament and the marked suture was measured*** for each side and recorded.
- Traction was continued until the avulsion rupture of the artery occurred.

- Elongation of the arteries just before the avulsion at each side with and without side branches was compared by the initial and last measurements of the distance from inguinal ligament to the marked suture.



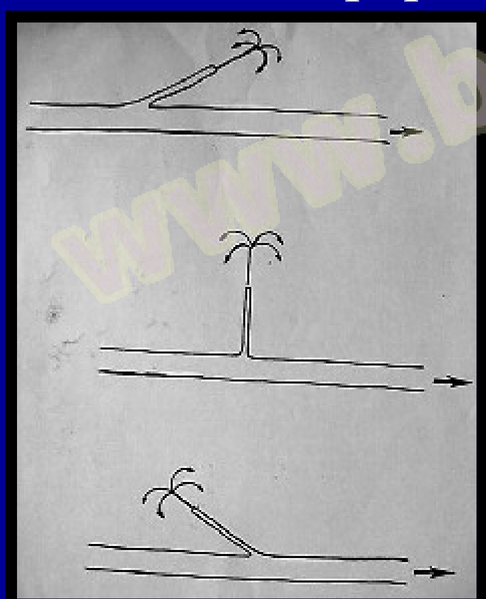
RESULTS

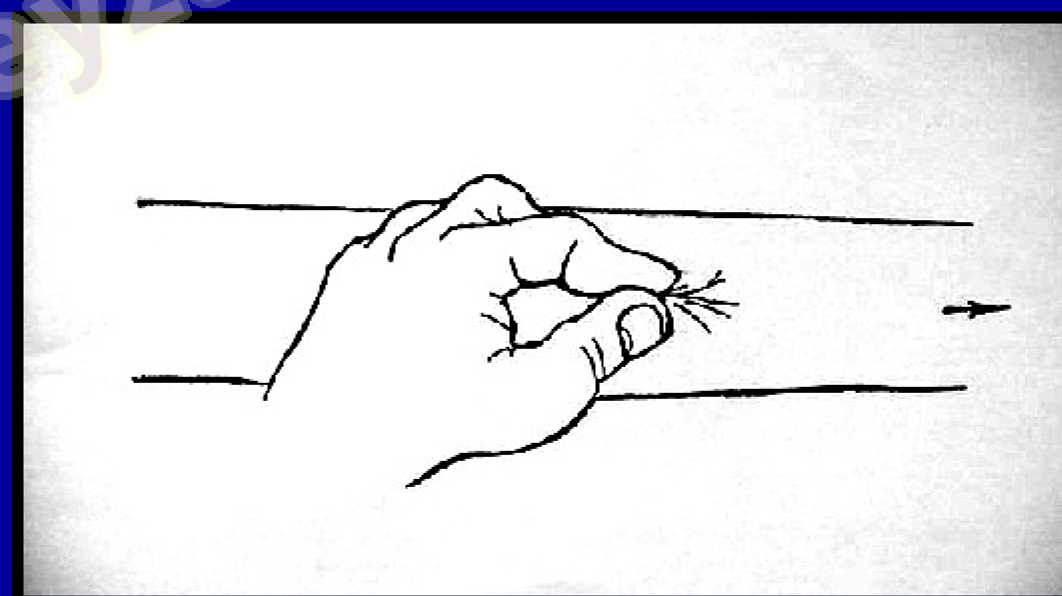
- *Observations during traction:* An average of 1.40 cm (1.25-1.50 cm) of elongation of the femoral artery was found between the inguinal ligament and the marked suture of the left legs at which the side branches were kept intact just before the femoral artery was ruptured by controlled traction.
- Elongation of the artery between these two points was measured an average of 3.00 cm (2.70-3.35 cm) just before the rupture at the right legs where the side branches were cut.

RABBIT	Inguinal Ligament – Sapheneous-Popliteal Artery Bifurcation (cm)	Before Avulsion	Inguinal Ligament – Mid-point (cm)			
			Last measurement just before avulsion			
			Left Leg (with side branches)		Right Leg (without side branches)	
			Total elongation	Elongation difference	Total elongation	Elongation difference
1	5.80	2.90	4.20	1.30	5.60	2.70
2	5.90	2.85	4.30	1.45	6.20	3.35
3	6.10	3.05	4.40	1.35	6.00	2.95
4	6.00	3.00	4.50	1.50	6.20	3.20
5	6.30	3.15	4.60	1.45	6.40	3.25
6	6.20	3.10	4.50	1.40	6.00	2.90
7	6.30	3.15	4.40	1.25	6.30	3.15
8	5.90	2.85	4.30	1.45	5.90	3.05
9	5.80	2.90	4.40	1.50	6.00	3.10
10	6.00	3.00	4.50	1.50	6.20	3.20
AVERAGE	6.00	2.99	4.40	1.41	6.00	3.08

RESULTS

- Side branches were observed to be tethered in a way to resist elongation of the trunk artery.
- The arteries without side branches at the right legs were lengthening more as they do not have any fixating and protective support that prevents elongation such as side branches.
- The rupture point was always distal to the amputation level and closer to the popliteal bifurcation where the artery was thinner.





DISCUSSION

- Traction of the vessels causes extensive damage within the vessel wall that cannot be recognized even under the operating microscope.
- *The main damage mechanism of the avulsion injury is the stretching of the arteries and resulting intimal tears.*
- If there are *sizeable and robust* side branches, the stretching decreases substantially.
- The side branches decrease the elongation of the trunk at their bifurcations by fixating the parent trunk that result a pull force against a fixed point that dispenses and diminishes the avulsion effect on the proximal segments.
- The traction force intensifies at the bifurcation points of the side branches.

DISCUSSION

- It is obvious that further extension, greater frequency and severity of the intimal tears affect the rate of thrombosis. Therefore, extensive vascular debridement and interposition vein grafting have been the gold standard in the treatment of avulsion type of injuries.
- In this study we tried to show the effect of side branches in stretching of the parent trunk with emphasis on preventing the ***mechanic and metrical effect*** of avulsion.

CONCLUSION

- Comparing the two legs with or without side branches showed an average of ***50% more*** elongation at the legs without side branches concluding a possible severe injury of the artery.
- The data have shown that unruptured side branches *may be* an indirect measure to locate the relatively suitable level of the artery for anastomosis.

CONCLUSION &
? SUGGESTION ?

- In the view of these results, we suggest performing microsurgical arterial anastomosis after resection past a minimum of two *unruptured* branch points of the avulsed part in order to have a more secure segment for better patency rate.

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Greetings From Istanbul

THANK YOU