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ORIGINAL ARTICLE

OUTCOME OF DELAYED REPAIR OF ARTERIES AT DISTAL FOREARM: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Delayed repair of arterial injuries, particularly in the distal forearm, poses significant challenges in terms of functional recovery and long-term outcomes. This study aimed to assess the outcomes of delayed arterial repair at the distal forearm, evaluating the functional recovery, vascular patency, and associated complications in patients who underwent repair after a significant delay.

Materials & Methods: A Cross sectional study done at Orthopedics and Traumatology Lady Reading Hospital-MTI Peshawar from January 2022 to January 2024. A total of 30 patients fulfilling the inclusion criteria were included who underwent frequency of patency of the arteries after delayed repair of the injured forearm arteries preceded by primary ligation. At the time of inclusion baseline characteristics of all the study participants were documented. Patients were assessed on monthly basis till completion of 12 months to assess for patency by "Allen test" and color Doppler ultrasound. Data was analyzed using SPSS 22:00.

Results: In our study, value of mean age was 23.33 ± 4.87 years. In our study, there were 23 (76.67%) male participants while remaining 7 (23.33%) participants were female. Mean duration since injury was 5.76 ± 2.08 days. In our study, injury to ulnar artery was more frequent 16 (53.33%) as compared to the radial artery 14 (46.67%). Frequency of patency of the arteries after delayed repair of the injured forearm arteries was 17 (56.67%).

Conclusion: Patency of the arteries after delayed repair of the injured forearm arteries preceded by primary ligation was only found in about half of the patient necessitating the requirement of urgent vascular intervention.

KEY WORDS: Delayed; Forearm; Ligation; Radial Artery; Repair; Ulnar Artery.

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INTRODUCTION

A traumatic vascular injury can damage the veins and arteries of the extremities, and it is particularly prevalent during times of war. These injuries can lead to hemorrhage and eventually ischemia if they are not treated. In the event that it is not treated appropriately, those who have been injured are at danger of being crippled or possibly passing away as a result of hemorrhagic complications.[1] It has been found that overall, 1% of the injuries that effect the limbs of a person are vascular injuries and amongst these peripheral vascular injuries, around half of those are the injuries to the arteries of the forearm.[2,3]

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Vascular trauma is a rare occurrence in the pediatric population, accounting for just 0.6% among all children and adolescents who have been treated for trauma. Penetration injuries in children are significantly more common than in adults, despite the fact that children experience them less frequently. The arteries of the upper limbs are the ones that are most usually wounded and are linked to a relatively low mortality rate.[4] A clinical assessment can reveal up to 80% of individuals who have vascular damage, and this assessment is capable of helping determine the presence of arterial injury in those patients. It is imperative to be aware that a negative clinical assessment does not necessarily exclude the possibility of injury to the vessels and imaging techniques should be utilized to make a definitive diagnosis.[5-7]

Injury mechanism, concomitant injuries, and length of time between trauma and provision of definitive

care are three most important factors that can have an independent effect on the outcome of the extremity in which vascular injury occurs.[8] When it comes to management of forearm arterial injury, modality of choice for intervention still remains controversial. In cases where the arteries of the forearm (radial/ulnar artery) are wounded in an adequately perfused arm, ligation of the injured artery was recommended in order to prevent thrombus formation in the healed vessel.[9] Contrarily, it has also been reported in studies that primary repair of these vessels within six hours of injury yields better functional outcomes.[10]

In our region, scarcity of the availability of vascular and hand surgery facilities is a major concern and most cases fail to reach a specialist surgeon within six hours due to which most cases in our settings undergo delayed or secondary repair of their arterial injuries of the forearm preceded by ligation. For this purpose, we conducted this study with the aim of determining the frequency of patency of the arteries after delayed repair of the injured forearm arteries preceded by primary ligation.

MATERIAL AND METHODS

This cross-sectional study was conducted from January 2022 and continued till January 2024 at Orthopedic and Traumatology department Lady Reading Hospital-MTI Peshawar after taking approval from Ethical review board of the institute. We calculated the appropriate sample size by using WHO sample size calculator[11] with confidence level to be at 90%, absolute precision at 10% and anticipated frequency of patency of the arteries after delayed repair of the injured forearm arteries of 87.5%[12] which was 30.

We included patients who were adults (i.e., having age more than 18 years), of either male or female gender, with injury to the arteries of the forearm (i.e., radial and ulnar artery) along with nerve and tendon injuries of more than six hours that had been subjected to primary ligation. We excluded patients who had already an arteriovenous fistula in place (in hemodialysis dependent patients) and those with history of graft placement in the forearm vessels. After selection of study pool we documented the baseline demographic characteristics of the study participants including age (in years), gender, artery injured (ulnar or radial) and duration since injury (in days). After that delayed or secondary repair of the respective artery was performed by the surgical team led by a consultant Hand surgeon in all the patients. After successful repair of the vessels patients were called for follow up visits on monthly basis till completion of 12 months to assess patients for the patency of the repaired artery by combination of "Allen test" and color Doppler of the forearm. The time for Allen test less than six second was considered positive and the artery was regarded to be patent.[13] Additionally, we used color Doppler ultrasound of the forearm to check the patency of the repaired vessel due to its high diagnostic accuracy.[14]

For data analysis we used Statistical Package for Social Sciences (SPSS) software version 22:00. To represent quantitative data we used mean with standard deviation (SD). For representation of qualitative data we used percentages and frequencies. Normality of data was checked using Shapiro-Wilk test.[15] To analyze quantitative data we used sample t-test and for qualitative data Chi-square test was utilized. A p-value of ≤ 0.05 was considered to be statistically significant".

RESULTS

In our study a total of 30 patients were included. The mean age of whole study population was 23.33 $\pm$ 4.87 years. In our study, there were 23 (76.67%) male participants while remaining 7 (23.33%) participants were female. Mean duration since injury was 5.76 $\pm$ 2.08 days. In our study, injury to ulnar artery was more frequent 16 (53.33%) as compared to the radial artery 14 (46.67%). This data is summarized in tabulated form below in table I:

Table I: Baseline characteristics

Sr. No.	Characteristics	Value
1	Mean age	23.33 $\pm$ 4.87 years
2	**Gender**	
	Male	23 (76.67%)
	Female	7 (23.33%)
3	Mean duration since injury	5.76 $\pm$ 2.08 days
4	**Artery injured**	
	Ulnar	16 (53.33%)
	Radial	14 (46.67%)

In our study, we found that the frequency of patency of the arteries after delayed repair of the injured forearm arteries was 17 (56.67%) while remaining 13 (43.33%) failed to remain patent, depicted below in figure 1.

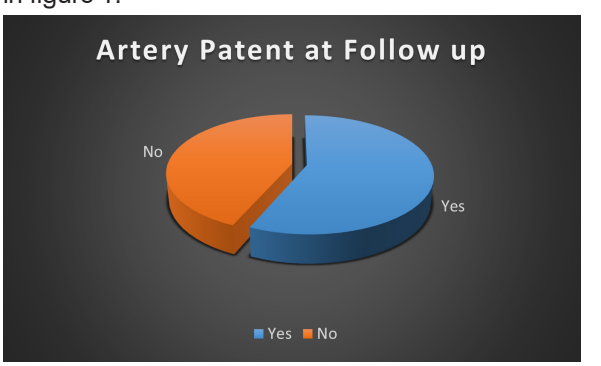

Figure 1: Frequency of Patency of Arteries after Delayed Repair

We also compared the frequency of patency of the arteries after delayed repair of the injured forearm arteries and found that in case of ulnar artery (n = 16), 12 (75.00%) were patent and 4 (25.00%) were

not patent at final follow up while in case of radial artery (n = 14), only 5 (35.71%) were patent and remaining 9 (64.29%) were not patent, (p = 0.030). This data is tabulated below in table II.

Table II: Patency Stratification by Artery Injured

Patency	Ulnar artery (n = 16)	Radial artery (n = 14)
Yes	12 (75.00%)	5 (35.71%)
No	4 (25.00%)	9 (64.29%)
p = 0.030		

DISCUSSION

Ischemia of the hand or fingers can occur seldom after an injury to one of the major arteries of the forearm. Ischemia can lead to necrosis of the tissue, thus repair must be done quickly. Nevertheless, in cases where there are no signs of ischemia is seen in the hand and more distally in the fingers, ligation or primary repair of the damaged vasculature might be possible [16, 17]. Despite this, researchers have shown that ligation could lead to various complications like atrophy of muscle and bone, cold intolerance and complications related to wounds.[9,18]

In our study, we found that majority of patients were of very young age in their twenties and most of these were males. This was congruent with the finding observed in a study by Sah *et al.*[19] in which majority of patients who had vascular injury had male gender. In our study, we found that more than half of the patients who had delayed repair of their arterial injury preceded by primary ligation making delayed repair a feasible, as concluded by Park *et al.*[20] who reported that no significant difference in frequency of arterial patency after emergency versus delayed repair. Contrary to this, much higher frequency of patency after delayed repair of injured forearm arteries was reported in a study conducted by Boretto *et al.*[12]. In our study, we found that there was a statistically significant difference between radial artery and ulnar artery in terms of frequency of patency of the arteries after delayed repair of the injured forearm arteries preceded by primary ligation. This finding, however, was contrary to a study conducted by Schippers *et al.*[21] in which it was found that no statistical difference was present between radial artery and ulnar artery in terms of frequency of patency of the arteries after delayed repair of the injured forearm arteries.

Based on findings of our study, it can be considered that even delayed repair is a useful option for management of arterial injury of the forearm but whether or not it can compete with the option of emergent repair is still to be researched. For this purpose, we recommend that further experimental trials should be conducted not only to determine the usefulness of delayed repair of injured forearm arteries but also compare its outcome with the emergency repair.

CONCLUSION

In conclusion, patency of the arteries after delayed repair of the injured forearm arteries preceded by primary ligation was only found in about half of the patient necessitating the requirement of urgent vascular intervention.

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CONFLICT OF INTEREST
Authors declare no conflict of interest.
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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design:	BH, SQ
Acquisition, Analysis or Interpretation of Data:	BH, SQ, SFQ, AUJ, AI
Manuscript Writing & Approval:	BH, SQ, SFQ, AUJ, MS

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.