

# MORPHOLOGY OF GRAFTED TENDON

## COMPARATIVE STUDY OF FIRST STAGE SILICONE RUBBER ROD IMPLANTATION

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**ABSTRACT:** This is the first research done to explore the morphologic changes in two stage tendon grafting as compared to one stage tendon grafting. **AIMS:** To compare morphology of grafted tendons with and with out first stage silicon rubber rod implantation. **STUDY DESIGN:** Comparative experimental study. **PERIOD:** 1994-2007. **MATERIAL AND METHODS:** 30 patients were included in this study. They was divided into 3 groups. Group 1 underwent 2 stage tendon grafting group 3 was used as control morphological study of tendons. **RESULTS:** Group 1 (1-stage) tendon grafting showed degeneration and fibrous reaction as morphological changes. Group 2. (2 Stage) appeared as normal tendons morphologically. **CONCLUSION:** This study concludes that instead of direct tendon grafting, two stage tendon grafting is recommended.

**Keywords:** Tendon Graft, Synovial Sheath, Palmaris Longus,

### INTRODUCTION

For damaged tendon where repair is not possible then tendon grafting procedure is done either by direct first stage tendon graft implantation or as two stage procedure by implanting silicon rubber rod in first stage and then replacing it with a tendon graft in second stage.

### AIMS AND OBJECTIVES

The aim and objective of this study is to compare the effects on tendon graft Morphology with or without use of silicone rubber implants as 1st stage procedure.

To see the difference in the Morphology of grafted tendon with or without first stage silicone rod implantation a detailed research was needed so that scientifically based recommendations can be formulated. To be more close to reality living tendons have been used from badly mutilated hands. This is the reason that this research took long time (more than ten years) to select extensively and badly mutilated hands, where sacrifice of Palmaris Longus tendon did not affect final functional capacity of limbs because all these hands ended up into above wrist amputation.

It took long time (1994-2007) to select such badly damaged & mutilated hands of volunteers. Pictures of some of this hand are presented in this paper all these hands underwent above wrist amputation. Fig-1-Fig-4



Fig-1.

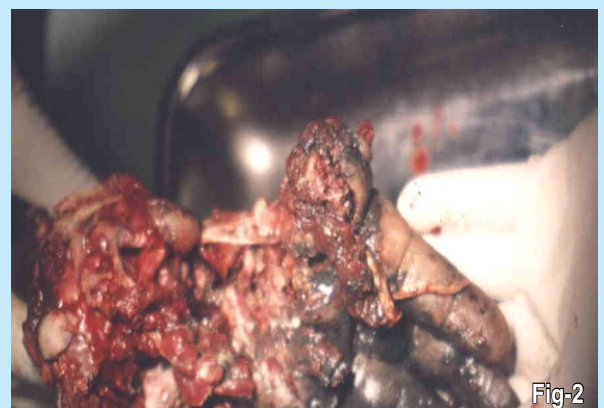


Fig-2

Picture Of Some Of The Badly Damaged  
Hands Used For Research



Fig-3

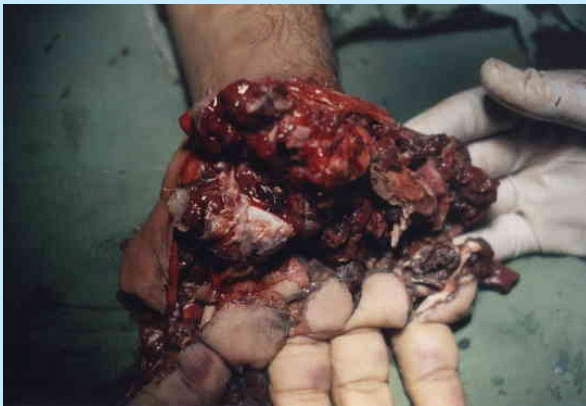


Fig-4

## MATERIAL AND METHOD

(Fig-5-9)

The Palmaris Longus tendon has been used for this research project. 30 cases were used in this project. The study was divided into three groups:-

### Group - I.

In this group 3 cm to 4 cm of Palmaris Longus tendon is removed, proximal to distal flexion wrist crease. The attained 3 cm to 4 cm of tendon was restitched back into the defect to act as 1st stage direct tendon graft. This grafted tendon was taken out after 03 weeks & subjected to morphological studies.

### Group - II.

The same limb, from where 3 cm to 4 cm of Palmaris Longus tendon was used in group I study, is now subjected to group II study. In this group 3 cm to 4 cm of

silicon rod was implanted on radial side of Flexor Capri Radialis (F.C.R) without disturbing the integrity of tendons. The site was proximal to distal wrist flexion crease.

The rod remained implanted for 03 months. After 03 months the silicon rod was taken out. Remaining whole of the Palmaris Longus tendon was taken out. Half of this attained tendon was grafted back in place of removed silicon rod in the synovial sheath formed by silicon rod. After 03 weeks the grafted tendon of group II was taken out of sheath & subjected to Morphological Studies.

### Group - III Control Group.

The remaining half of Palmaris Longus tendon (P.L) (attained from group II) was subjected to morphological studies as to give normal reference readings of used Palmaris Longus Tendon.

## MORPHOLOGICAL STUDIES AND RESULTS

The patient age ranged from 08 years to 50 year. Only four were child (08-13 years). Rest 26 cases were in the



Fig-5. Showing process of implantation of silicon rod and obtaining part of palmaris longus tendon for group- I study



Fig-6. Showing completion of silicon rod implantation



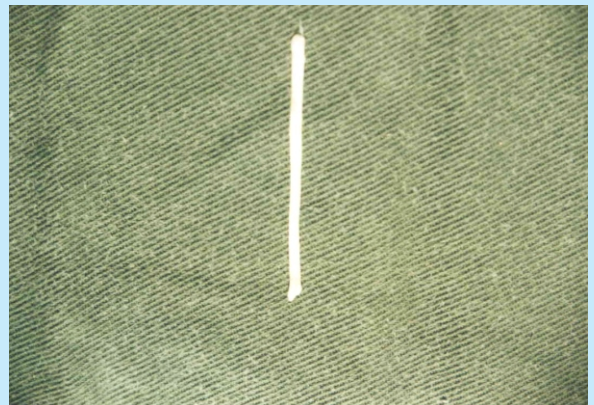
**Fig-7. Showing group-I tendon graft in place**



**Fig-9. Showing group-II tendon graft dissected out with surrounding synovial sheath**



**Fig-8. Showing the removal of silicon rod after 3 weeks**



**Fig-10. Showing freshly obtained part of palmaris longus tendon for group-III study**



**Replacements By Part Of Palmaris longus Tendon In The Preformed Synovial Sheath**



**Fig-11. Part of palmaris longus tendon removed for group-II study (observed it is much identical to previous fig (12) in appearance)**



Fig-12. Part of palmaris longus tendon removed from group-I study (grossly these tendons seems to be a mixture of fibrous and tendon tissues)

age group from 18 years to 55 years. Out of 30 cases five were females. In all these cases the tendon grafts silicon rods were placed in normal healthy vascularized areas of volar aspect of forearms.

Grossly, the tendons of Group II (Fig-11) appear like a normal tendon Fig-10 however Group I Fig-12 tendons appear grossly a mixture of degenerated tendon tissue & fibrous tissue with loss of normal gross texture as compared to normal tendon.

The removed tendon graft were histologically examined using light microscope to evaluate the morphological features of the graft and compare these with the morphology of control normal group-III. The tissue removed were fixed in 10% buffered formalin and stained with Haematoxylin and Eosin.

### RESULTS OF HISTOLOGY EXAMINATION

Histology of normal Palmaris Longus tendon is shown in Fig (13-14). It shows normal tendon, showing bundles of collagen fibers, arranged in fascicles with loose connective tissue, surrounded by layer of flattened fibroblasts, vascular and nerve bundles. No evidence of calcification or hemorrhage seen.

All the tendons of group-II has same histological picture. (Figs 15,16,17,18) show bundles of collagen fibers surrounded by regenerating fibroblasts with longitudinal

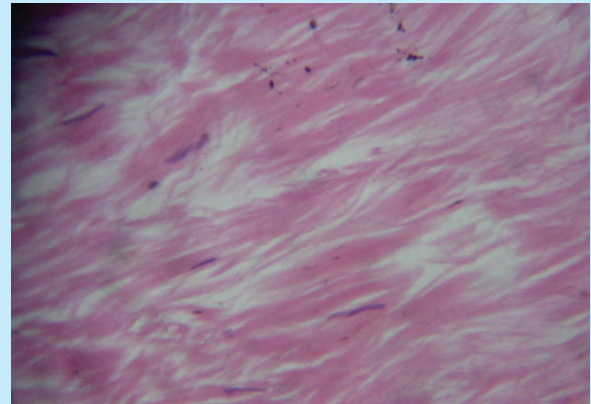


Figure-13 -10x Normal Tendon.

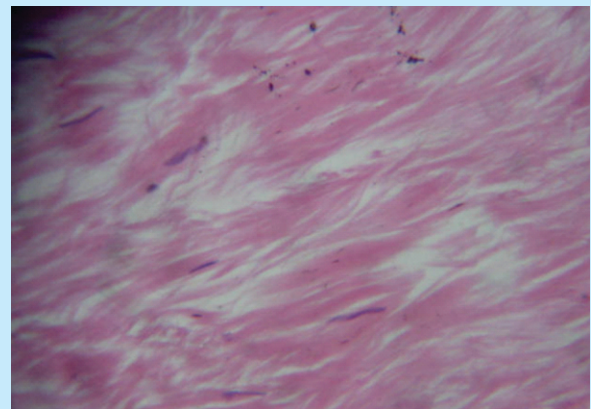


Figure-14 - 40x Normal Tendon.

and prominent nuclei. There are areas of regenerating vascular and nerve supply to these newly developed collagen fibers with successive fasciculation. No areas of calcification or hemorrhages seen. At places more aggregations of fibroblasts are seen, showing more reactive changes.

All tendons of group-I has same histological picture. Histological examination of the section reveals bundles of thicker collagen fibers than normal one. There is no surrounding layer of fibroblasts, vascular and nerve bundles. These are not arranged in fascicular pattern and showing hyalinization appearing as wider sheets of densely hyalinized dead tissue (Fig-19). At places fragmentations are apparent (Figs-20, 21). There are areas of calcification and old hemorrhages.

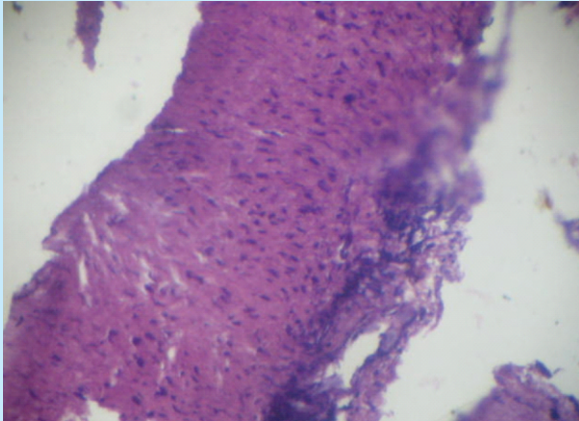


Figure 15 - 10 x Group II with massive regeneration.

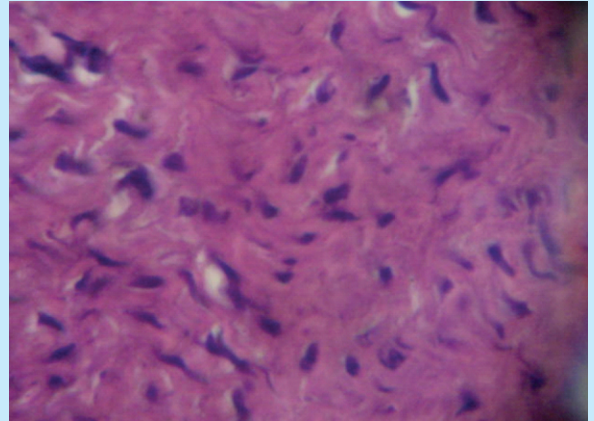


Figure 18-40x group II organized newly formed tendon.

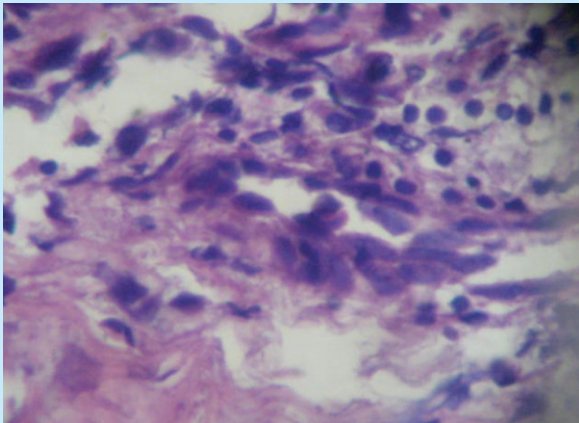


Figure 16 - 40x Group II new blood vessels formation

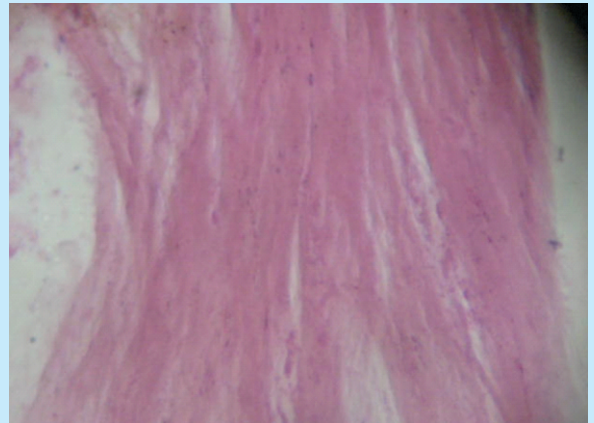


Figure 19 - 40x Group I with hyalinization.

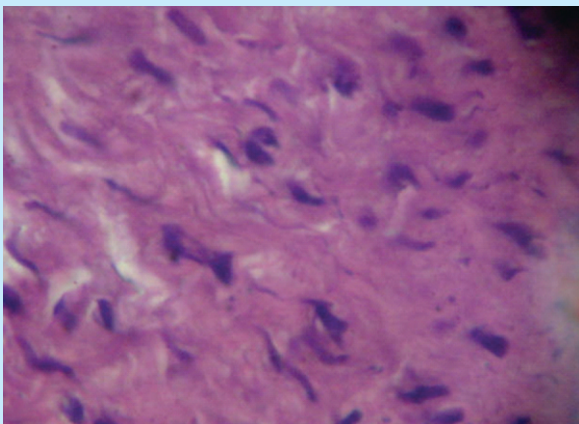


Figure 17 - 40x Group II newly formed tendon

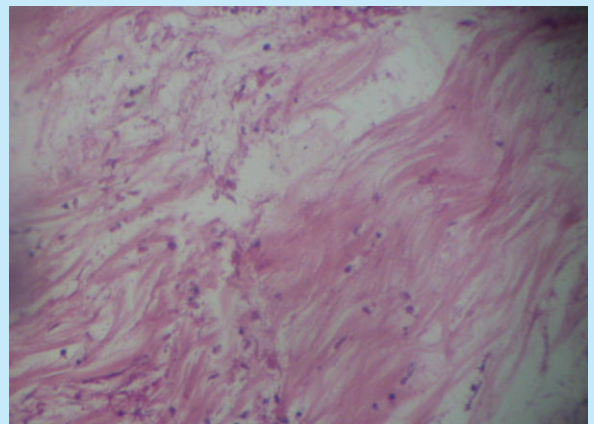


Figure 20 - 10x Group I with fragmentation.

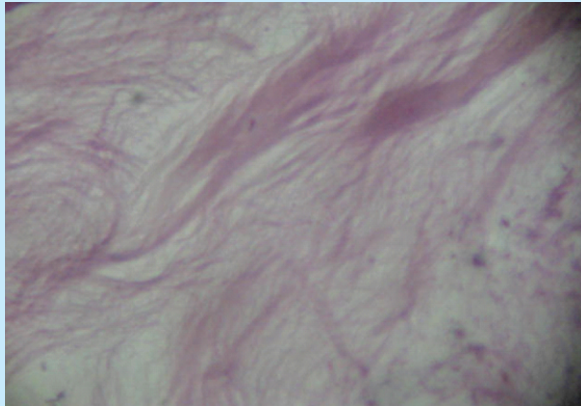


Figure 21 - 40x group I with fragmentation.

## DISCUSSION

Different complications have been noted with free tendon grafting 1,2,3,4,5,6,7. The most common problem to this procedure is failure of tendon graft to attain function due to adhesions (Schneider 1993) 8,9,10 or breakage of graft (Wilson 1985)11.

Flexible silicone rubber rods were used as first stage of tendon grafting to avoid adhesions formation which allow passive or (in the case of "active" implants) active motion 12,13,14,15. Their use was pioneered by Bassett and Carroll, and subsequently by Helal, and Hunter and his colleagues 16,17,12,13,17,18,19,20,21,,22,23

Bassett and Carroll 1 reported excellent results by using silicon rubber implants Actually their report in 1963 highlighted the formation of digital tendon sheath around the implanted silicon tendon,20

The purpose of this study is to determine whether by use of silicone rod in 1st stage, the grafted tendon in stage II continue to retain normal morphology as compared to the tendon graft done without prior placement of silicone rod. No work has been presented to check the effects on morphology of grafted tendon with or without use of silicone rod first stage implantation. 23,24,25,26,27,28, 29,30,31,32,10,33,34,35,36,37,38

The results of this study are so clear and obvious that a long discussion is not needed. The results analysis can be stated very clearly and briefly as follow:-

This study has clearly proven that morphology of tendon grafts in Group II is closer to the normal tendon of group-III. In Group I the tendon lost its both gross and histological features as discuss in the results of studies

The reason of retaining normal morphology at the end of 03 weeks by group-II tendon grafts as compared to group-I tendon grafts is explained by the formation of synovial sheath around silastic rod 38. This synovial fluid secreted by this synovial sheath provide nutrition Rayner 39,38 to the avascular tendon graft of Group II & hence helped to maintain vitality of tendon graft architecture which in turn helped in maintaining the tensile strength and morphology (Group II tendon grafts) to normal.

The importance of synovial fluid diffusion in tendon nutrition has been demonstrated by Lundborg and others 37. This nutrition system nourishes second stage tendon graft especially in initial few weeks 4 to 5 prior to blood vessels invasion and adhesion formation. Synovial Pseudo Sheath formation concept was explained by Mayer and Ransohoff 40.

This scientific research proves that after 03 weeks the tendon grafts done with prior 1st stage silicon rod implantation retain more normal morphological features than tendon grafts done in 1st stage without silicon rod implantation. Hence early active physiotherapy is safer in tendon grafts done after silicon rod implantation. Early active physiotherapy is essential to protect tendon graft from adhesion formation.

## CONCLUSION

The result of this research recommends that instead of direct tendon grafting, it should be done after first stage silicon rod implantation. By this staged procedure, the tendon graft continues to retain normal healthy morphology after 03 weeks of grafting and hence can be subjected to early active physiotherapy without danger of rupture as compared to tendon grafts directly placed without 1st stage silicon rod implantation.

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**A true friend never gets  
in your way unless you happen  
to be going down.**

*Arnold H. Glasow*