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Comparison of tensile strength of continues-core method and 4 strand modifies method of after healing of repaired Kessler rabbit's Achilles tendon injury

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Comparison of tensile strength of continues-core method and 4 strand modifies method of after healing of repaired Kessler rabbit's Achilles tendon injury

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Abstract. Tendon injury causes significant morbidity during the productive age, and the number is increase in recent decades. Tensile strength is the most important factor in tendon function of style, and the results of repair should be able to withstand large current style of early mobilization. This research was an experimental research design with the post-test only control group design with the subject of the rabbit. A total of 18 research subjects who meet the requirements of the study inclusion were randomly divided into treatment and control groups. Control group was a group of rabbits that were repaired with 4 strand modified Kessler technique after Achilles tendon cut sharply. While the treatment group were a group of rabbits that were repaired with continuous-cores technique. The ratio of collagen I /III in rabbit Achilles tendon repair with the technique of continuous-cores are smaller compared to the control group with value of $P < 0.05$. Also Showed statistical analysis tensile strength of rabbit Achilles tendon repair with the technique of continuous-core is greater than the control group at $P < 0.05$.

Keywords: Achilles, tendon, injury, rabbits, tensile strength, continuous-cores method, 4 strand modifies method

1. Introduction

Injuries to the tendons become a significant cause of morbidity in the population of productive age. These injuries often experienced in sports injuries or traffic accidents, and addressed by a wide range of specialist and non-specialist personnel. The number is increasing in recent decades. The process of handling the tendon injury is still a challenge for orthopedics specialist doctors for healing tendon cause a variety of problems in terms of both anatomy and function [1].

Tendons are the connective tissue that lies between the bone and muscles that serves to transmit the force produced by skeletal muscles by maintaining posture and joint movement. Most injuries to the tendons occur in areas close to the joints, such as shoulders, elbows, knees, and ankles. Injury to the



joints accompanied by partial or complete tear of a tendon occurs as much as 45% of all musculoskeletal injuries each year. Injuries to the tendon is quite often the case with the percentage of 30% - 50% of all injuries. These injuries mainly occur due to traffic accidents or sport injuries [1]

Injuries to the tendons vary from minor injuries that have relatively minimal risk to the daily activities, up to a tear in the tendon that requires surgery. Complications are common due to tendon injuries are disturbances spasticity, rigidity and reduced the power of the tendon itself. At the end of tendon function as a buffer as well as the nature of viscoelastic to reduce muscle damage will be decreased so that the movement and function of protection is limited [1-3].

The main purpose of tendon healing is to restore mechanical function where the tendons have a poor spontaneous regenerative capacity after injury, making it difficult to regain the biological and biomechanical function as before the injury. This is due to the formation of adhesions and scar tissue which inhibits the regenerative process of the tendon [3].

At the tendon healing process, there is a change in the type and distribution of collagen tissue that is formed. There is a decrease in the ratio of collagen type I / type III where an increase in type III collagen synthesis compared to Type I. Collagen type III formed more and much thinner than type I as well as the cross-linking of collagen fibres that form only 45% and most immature. The synthesis of type I collagen in tendon injury grade III will decline and be replaced by increased synthesis of collagen type III along with the expansion of granulation tissue and remodelling process so that the ratio of collagen type I / III decreased and the substitution of collagen towards the formation of scar tissue and fibrosis. Scarring of the tendon can cause a decrease in adhesion and tensile strength of up to 20% [4-7].

Tensile strength is the most important factor in the primary function of the tendon as a conductor of force, and therefore the results of repair should be able to withstand great force created when the initial mobilization. This leads to a lot of different repair techniques with a focus on increasing the tensile strength [8].

2. Experimentals

The experiment was conducted with the aim to prove different in tendon reconstruction technique that will reduce the collagen type I / type III ratio and increase of the tensile strength of the tendon after healing. This study is an experimental research design using post-test only control group design with the subject rabbits from eligible subject population with randomized sampling.

Thirty-six adult male New-Zealand white rabbits of the same age (12 weeks) weighing 2 - 3 kg were used in this experiment. All the animal was given adequate food and water in the laboratory. These rabbits were randomly divided into control and treatment groups. The control group was repaired with continuous-cores (Fig. 1), while the treatment group was compared with core repaired with 4 strand modified Kessler technique (Fig. 2) after Achilles tendon (Fig. 3) had been cut sharply and sewn with the non-absorbable nylon thread (4-0 monofilament), followed with immobilization of the affected limb with a cast. This technique uses six cores that divide the load at six anchor and multi strand locations. The addition of the number of core and node points can significantly increase the strength and resistance to the existence of gaps.

After that, the rabbits were sacrificed and the Achilles tendon was isolated for further examination. The rabbit tendon tissues were examined for tensile strength in the vertical direction in which the tendon is stretched until failure load with the universal testing machine. The immunohistochemistry examination is then performed to know the ratio of collagen type I / III. This procedure is carried out with rabbit tendon tissue fixation using 10% neutral buffered formalin and processed for routine histological preparations with antimouse collagen I/III antibody and antimouse IgG secondary antibody / biotin which has been conjugated with horseradish peroxidase. The calculation of the amount of collagen, tendon using the Image J Network processing.

The obtained data were presented as mean SD of number of rabbits (n) that were used in the experiment. The mean difference was analyzed with independent t-test for statistical significant of Examined variables i.e. the tensile strength and the ratio of collagen I / III. The difference was assumed to be significant at $P < 0.05$.

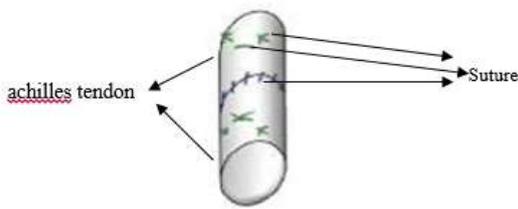


Figure 1. Continuous-cores technique

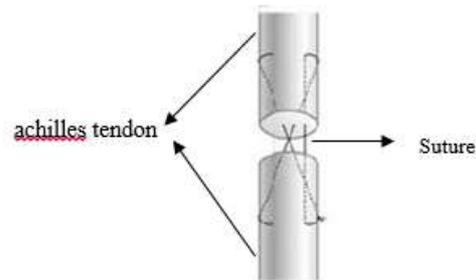


Figure 2. Four-strand modified Kessler technique

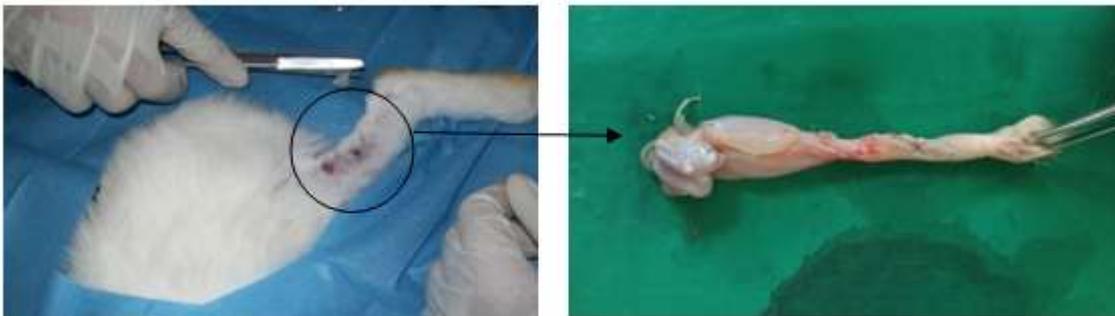


Figure 3. Rabbit Achilles tendon

3. Results and discussion

The distribution of the research subjects are as many as 32 subjects. The treatment group was compared with core repaired with 4 strand modified Kessler technique as much as 16 or 50.00% of the total subjects and the control group was repaired with continuous and cores as many as 16 or 50.00%.

The mean of the tensile strength in the treatment group was 62.34 ± 7.7173 N, while the average tensile strength in the control group was 50.37 ± 3.8275 N. The highest tensile strength was 62.34 ± 7.7173 N in the treatment group and the minimum tensile strength was 50.37 ± 3.8275 found in the control group. The mean percentage of type III collagen in the treatment group was 16.56 ± 1.9676 N, while the control group was 26.74 ± 2.5134 N.

The mean of collagen type I in the treatment group was 87.33 ± 1.1937 , while in the control group was 73.42 ± 3.5091 . The ratio of collagen I / III in the treatment group was 5.3463 ± 0.6934 compared with the control group 2.7668 ± 0.2795 .

Fig. 3 Showed that the tensile strength is higher in the treatment group compared with the control group, and the mean difference between treatment and control group was statistically significant with $p = 0,051$ ($P < 0.05$). While the ratio of collagen type I / III in the treatment group is smaller than the control group, and the mean difference between treatment and control group was statistically significant with $p = 0,056$ ($p < 0.05$).

Based on the results of parametric analysis by using t-independent obtained the difference statistically significant between treatment groups with the control group, where the ratio of collagen I / III in the group treated with the technique of continuous-core is smaller compared to the control group by using 4 strand modified Kessler.

Based on the results of the parametric analysis with independent t-test found any statistically significant difference between the treatment group and control group, in which the tensile strength of the tendon in the group treated with the technique of Continuous and Core is greater than the control group at 4 Strand Modified Kessler technique.

The mean tensile strength of the Achilles tendon after treatment is still in the normal range of tensile strength in rabbits, but the strength after maximum loading decreased compared with normal tendon.

This is consistent with the study by Woo et. Al. [4] stating that the biomechanical component remains inferior tendon after injury grade III.

At the tendon healing process, there is a change in the type and distribution of collagen tissue that is formed. There is a decrease in the ratio of collagen type I / type III where an increase in type III collagen synthesis compared to Type I [7]. Collagen type III formed more and much thinner than type I as well as the cross-linking of collagen fibers and most immature [5]. The synthesis of type I collagen in tendon injury grade III will decline and be replaced by increased synthesis of collagen type III along with the expansion of granulation tissue and remodeling process so that the ratio of collagen type I / III decreased and the substitution of collagen towards the formation of scar tissue and fibrosis [4,6].

4. Conclusion

The ratio of type I/III I collagen in healing of achillestendon injuries in rabbit that are repaired by Continous-core techniques are lowered than the tendon repaired by 4 Strand Modified Kessler technique. Tensile strength that we measure in rabbit achilles tendon healing after injuriethat repair using Continous-core techniques is higher than achiles tendon that is repaired by 4 strand modified Kessler technique.

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