Thickness of Tidemark in Enthesis Fibrocartilage at Distal Epiphyseal Attachment of Quadriceps Tendon and Semimembranosus Tendon

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Abstract

Background: To compare width of zone of tidemark at distal attachment of quadriceps tendon and semimembranosus tendon by routine histology in view of their role as mechanical barrier and site for osteoarthritic live degenerative changes.

Methods: The specimens of right sided distal attachment of quadriceps tendon on patella and semimembranosus tendon on tibia were collected from 20 male cadavers of adult age not beyond 40 years from autopsy room, within 24 hours of death. After fixation, dehydration and processing 5um serial sections were cut at 500µm interval along the long axis of the tendons. The varying thickness of tidemark were calculated.

Results: There were four zones at the attachment sites. These included (1) tendon (2) uncalcified fibrocartilage, (3) calcified fibrocartilage, (4) bone. The zone of uncalcified fibrocartilage was separated from calcified fibrocartilage by calcification front called tidemark. There were marked differences in width of zone of tidemark between quadriceps tendon and semimembranosus tendon insertion.

Conclusion: The thickness of zone of tidemark is greater in semimembranosus tendon than quadriceps tendon. As quadriceps tendon is strong extensor with greater mobility and exert more force than semimembranosus which is one of weak flexor of knee joint, so width tidemark is more in semimembranosus tendon than quadriceps tendon.

Key Words: Epiphysis, Quadriceps tendon, Semimembranosus tendon, Tidemark

Introduction

The enthesis is the point of insertion of the tendon, ligament, joint capsule or fascia to bone. There are two types of enthesis. Fibrous enthesis and fibrocartilaginous enthesis. Fibrous enthesis is characterized by pure dense fibrous connective tissue that links the tendon or ligament to the bone. The fibrocartilaginous enthesis is characterized by a transitional zone of fibrocartilage at bone-tendon interface. Microscopically it has four zones. These include pure ligament or tendon, uncalcified fibrocartilage, calcified fibrocartilage and bone. Zones of uncalcified fibrocartilage and calcified fibrocartilage are collectively called enthesis fibrocartilage. Enthesis fibrocartilage reduces wear and tear and forms one of the protective devices. Enthesis fibrocartilage is also the site of pathological changes during ankylosis spondylitis and spondyloarthopathies. The layers of calcified and uncalcified fibrocartilage at an enthesis are separated by calcification front called as tidemark. Although tidemark separates the calcified and uncalcified fibrocartilages, the collagen fibers in two layers are continuous. The tidemark is smooth at sites with much uncalcified fibrocartilage.

Patients and Methods

From central portion of attachment zones of quadriceps tendon (group A) and semimembranosus tendon (group B), strips approximately 3mm were taken. The specimens were taken from right sided knee joints (devoid of gross pathological changes) of 20 male humans not beyond 40 years old from autopsy room of District Headquarter Hospital, Rawalpindi. The specimen were fixed in 10% neutral buffered formalin, decalcified in 2% nitric acid (end point being determined by palpation), dehydrated with graded alcohols, cleared in inhibisol and embedded in paraffin. Serial sections were cut at 5µm and two sections were obtained after each 500µm interval along the long axis of the tendons and stained with hematoxyline and eosin. The width of tidemark was measured with the help of ocular micrometer. The arithmetic mean of observations and standard error of the means were calculated. t-test was used to analyse the significant difference between two group A & B. The difference was regarded significant, if the p-value was equal to or less than 0.05.

Results

There were striking differences between the width of zone of tidemark at insertion of quadriceps tendon and semimembranosus tendon (Table 1). The width of...
zone of tidemark was greater in tendon of semimembranosus (mean 0.2440um ± 0.03089), i.e, it exceeded the width of zone of tidemark in quadriceps tendon. (mean 0.1167um ± 0.01234) (Table 1;Figure 1 & 2.

Table 1: Comparison of width of tidemark in group A & B

<table>
<thead>
<tr>
<th>Tidemarks</th>
<th>Group</th>
<th>N</th>
<th>Mean (um)</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
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</thead>
<tbody>
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<td></td>
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<td>20</td>
<td>0.1167</td>
<td>0.01254</td>
<td>0.00319</td>
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<tr>
<td></td>
<td>GroupB</td>
<td>20</td>
<td>0.2440</td>
<td>0.03089</td>
<td>0.00798</td>
</tr>
</tbody>
</table>

Figure 1: Quadriceps tendon insertion into patella (group A), showing nuclei of chondrocytes (Nc) in the zone of uncalcified fibrocartilage: tidemark, calcified fibrocartilage, lamellar bone. 1040, H&E stain

Figure 2: Semimembranosus tendon insertion into tibia (group B), showing nuclei of chondrocytes (Nc) in the zone of uncalcified fibrocartilage, tidemark, calcified fibrocartilage, lamellar bone. 1040, H&E stain

Discussion

An enthesis is the attachment of tendon, ligament or capsule to bone.7,8 It is also called insertional complex. Enthesis is either fibrous or fibrocartilaginous depending upon the nature of tissue at tendon-ligament-bone interface. Fibrous enthesis are present at diaphysis or metaphysis of long bone.9,10 Fibrocartilagenous enthesis are more common than fibrous enthesis.11,12,13 This insertional complex includes tendon uncalcified fibrocartilage, tidemark, calcified fibrocartilage and bone itself.14,15,16 The layers of calcified and uncalcified fibrocartilage at an enthesis are separated by calcification front that is commonly called tidemark. It is an interface at which soft tissue separate from hard ones.

The present study suggested that there were striking differences in the width of zone of tidemark at the epiphyseal attachment sites of quadriceps tendon and semimembranosus tendon. The thickness of zone of tidemark was maximum in semimembranosus tendon than quadriceps tendon. As quadriceps tendon is strong extensor, it exerts more force and mobility, so tidemark is smooth and less in thickness than semimembranosus which is one of flexor of knee joint.

Conclusion

1. The thickness of tidemark was greater in semimembranosus tendon than quadriceps tendon.
2. As quadriceps tendon is strong extensor with greater mobility and exerts more force so tidemark is smooth and decreased in thickness than semimembranosus.

References