Histological characteristics and ultrastructure of polyethylene terephthalate LARS ligament following the reconstruction of anterior cruciate ligament in rabbits

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Abstract

BACKGROUND: LARS ligament was designed by JP Laboureau in 1985. Clinical applications have proved the artificial ligament is satisfactory in a middle- and short-term, but few reports the histological turnover after implantation.

OBJECTIVE: To study the histological characteristics and ultrastructure of polyethylene terephthalate (PET) LARS artificial ligament after the reconstruction of anterior cruciate ligament in rabbits.

DESIGN, TIME AND SETTING: Randomized control experiments were conducted at the laboratory in the Second Affiliated Hospital of Soochow University from January to December in 2007.

MATERIALS: PET LARS ligaments were the stump of artificial posterior cruciate ligament obtained from operations (provided by Shanghai Kelong Company Limited). Twelve skeletally matured New Zealand white rabbits were used in this study.

METHODS: Twelve rabbits were divided into two groups according to systematic sampling. The PET LARS was transplanted to substitute the original anterior cruciate ligament, and the transplanted PET LARS was covered with the remnant of anterior cruciate ligament in 9 rabbits (L-LARS group), while only PET LARS was transplanted in 3 rabbits, which no covering with the remnant of anterior cruciate ligament (LARS group).

MAIN OUTCOME MEASURES: The grafts and synovium were harvested at 1, 3 and 6 months after implantation, and were processed into the stain by hematoxylin-eosin and Masson. Transmission electron microscope investigation was performed on the grafts at 6 months to observe ultrastructural findings.

RESULTS: At 1 month after implantation, the grafts in joints were covered with recipient connective tissues in L-LARS group, but were not covered anything after 6 months in LARS group. At 3 months, there were moderate to severe inflammatory reaction or foreign body reaction adjacent to the LARS fibers in bone tunnel or between LARS ligament fiber bundles. At 6 months, there were still irregularly aligned collagen fiber bundles slightly or in some portions. The tissue in the LARS ligament showed no mature ligamentization. Inflammatory cell reaction or foreign body reaction began to diminish. Marked trabecular bone grew into the bone tunnels, newly formed woven bone originated from the wall of bone tunnel and grew into the artificial materials. Electron microscopy investigation showed the tissue near LARS fibers was highly cellular with collagen fibrils (50−100 nm diameter). Among the collagen fiber bundles of the stroma were numerous osteoblasts and fibroblasts that were elongated, with large nuclei and an abundant, granular endoplasmic reculum.

CONCLUSION: The PET LARS ligament show good biocompatibility. Using recipient tissues cover LARS ligament could facilitate its “biolization”. Whether there is bone ingrowth in the bone tunnel of this artificial ligaments should be investigated further.

Yu SB, Dong QR, Wang YB, Zuo ZN, Li DG.Histological characteristics and ultrastructure of polyethylene terephthalate LARS ligament following the reconstruction of anterior cruciate ligament in rabbits.Zhongguo Zuzhi Gongcheng Yanjiu yu Linchuang Kangfu 2008;12(36):7061-7066 [www.zglckf.com/zglckf/ejournal/upfiles/08-36/36k-7061(ps).pdf]

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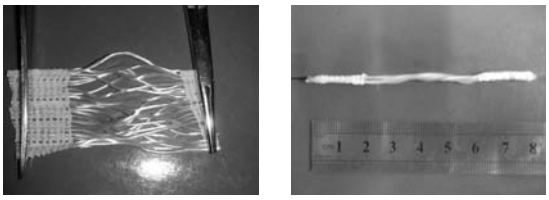
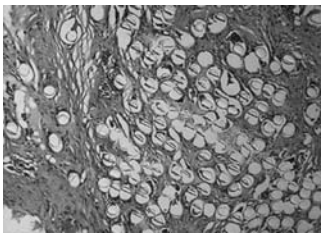


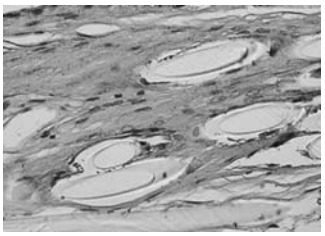
a: The unfolded remnant of LARS ligament

b: The prepared LARS ligament grafts

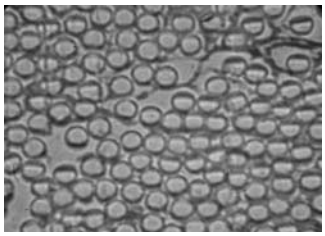
Figure 1 The preparation of grafts using the remnant of LARS ligament



a: Collagen fibers grew into the inter-fiber of LARS ligament in the group of L-LARS at one month after implantation (×100)

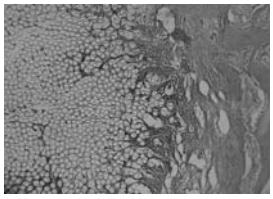


b: Collagen fibers appeared to be more oriented in the group of L-LARS at six months after implantation (×200);

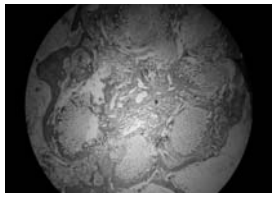


c: No collagen fibers ingrew into the inter-fiber of LARS ligament in the group of LARS at six months after implantation (×100)

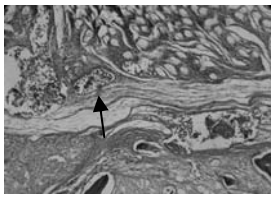
Figure 2 Histology of LARS ligament grafts (Hematoxylin-eosin staining)



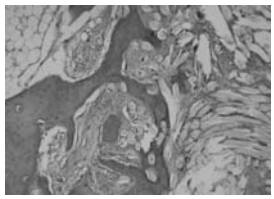
a: Fibrous connective tissues filled the bone-artificial ligament and grew into the artificial ligament fiber bundles at one month after operation (×100)



b: Fibrous connective tissues encapsulated the LARS ligament at three months after operation (×200)

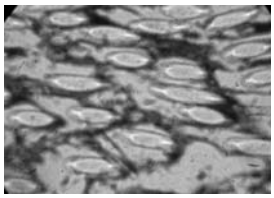


c: Inflammatory response appeared in bone tunnel in the group of LARS (Arrow indicated megakaryocytes)

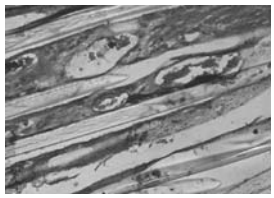


d: New woven bone encapsulated partial fibers of LARS ligament at six months after operation (×400)

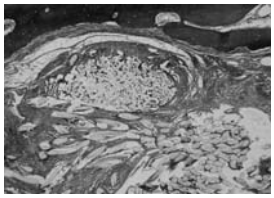
Figure 3 Histology of bone tunnel of grafts in the groups of LARS and L-LARS (Hematoxylin-eosin staining)



a: Collagen fibers grew into the fiber bundles of LARS ligament at one month after operation in the group of L-LARS (×100)

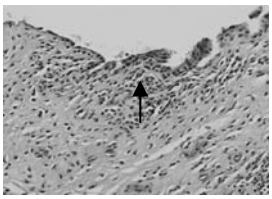


b: New vessels appeared among the fibers of LARS ligament at three months after operation in the group of L-LARS (×100)



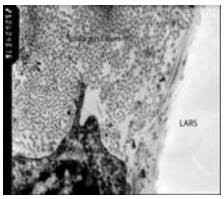
c: The detritus were noted among the fibers of LARS ligament in the bone tunnel at six months after operation in the group of LARS (×100)

Figure 4 Photograph of LARS ligament stained by Masson

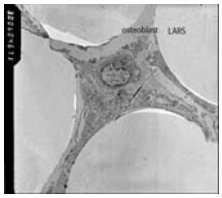


Inflammatory response remarkably decreased in the group of LARS (Arrow indicated monocytes)

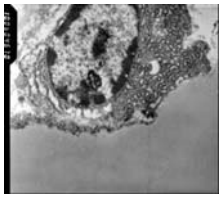
Figure 5 Histocompatibility of the grafts (×100)



a: Among the artificial fiber, the collagen fibers were observed at six months after operation in the group of L-LARS (×3 000)



b: Among the artificial fiber, many fibroblasts were observed with dilated cisterns in their granular rough endoplasmic reticulum (×10 000)



c: Among the artificial fiber, many osteoblasts were observed with dilated cisterns in their granular rough endoplasmic reticulum (×10 000)

Figure 6 Ultrastructure of the grafts

1 Mascarenhas R, Macdonald PB. Anterior cruciate ligament reconstruction: a look at prosthetics - past, present and possible future.Mcgill J Med 2008;11(1):29-37

2 Poddevin N, King MW, Guidoin RG. Failure mechanisms of anterior cruciate ligament prostheses : in vitro wear study . J Bio med Mater Res 1997; 38(4):370-381

3 Amis AA, Kampson SA. Failure mechanism of polyester fiber Anterior cruciate ligament implants: a human retrieval and laboratory study. J Biomed Mater Res 1999; 48(4):534-539

4 Frank CB, Jackson OW. The science of reconstruction of the Anterior cruciate ligament. J Bone Joint Sury 1997; 79 (A) :1556-1576

5 Laboureau JP,Marnat-Perrichet F.Isometric reconstruction of the anterior cruciate ligament.Determination of the femoral and tibial tunnels.Acta Orthop Belg 1996; 62 (Suppl 1): 166-177

6 Ibrahim SA, Ahmad FH, Salah M, et al. Surgical management of traumatic knee dislocation.Arthroscopy 2008;24(2):178-187

7 Dominkus M, Sabeti M, Toma C,et al.Reconstructing the extensor apparatus with a new polyester ligament.Clin Orthop Relat Res 2006;453:328-34

8 Wu YL,Wu HS,Li XH,et al.Shiyong Guke Zazhi 2007;13(1):4-6
Wang Y.Guowai Yixue:Chuangshang yu Waikexue Jichu 1999;20(1): 27-29
Lavoie P, Fletcher J, Duval N. Patient satisfaction needs as related to knee stability and objective findings after ACL reconstruction using the LARS artificial ligament. Knee 2000; 7(3): 157-163

9 Nau T, Lavoie P,Duval N.A new generation of artificial ligaments in reconstruction of the anterior cruciate ligament. J Bone Joint Surg (Br) 2002; 84(3): 356-360

10 Chen SY,Hong GW,Chen JW,et al.Zhongguo Yixue Gongcheng 2007; 15 (12) :949-953
Dong QR,Xu YJ,Cheng HN,et al.Jiangsu Yiyao 2007; 33(10):987-988
Trieb K, Blahovec H, Brand G,et al. In vivo and in vitro cellular in growth into a new generation of artificial ligaments. Eur Surg Res 2004; 36(3): 148-151

11 The Ministry of Science and Technology of the People's Republic of China. Guidance suggestion of caring laboratory animals. 2006-09-30 [2008-4-25].http://www.most.gov.cn/zfwj/zfwj2006/200512/t20051214_54389.htm.

12 Talbot M, Berry G, Fernandes J, et al.Knee dislocations: experience at the Hôpital du Sacré-Coeur de Montréal. Can J Surg 2004 ;47(1):20-24

13 Fan QB,Fan JF.Zhongguo Xiufu Zhongjian Waike Zazhi 2008;22 (6):676-679