Regeneration of rotator cuff tear using electrospun poly (DL-lactide-co-glycolide) (PLG) scaffolds in a rabbit model

Introduction
Various surgical procedures are available for the repair of massive rotator cuff tear, such as musculotendinous transfer and patch grafting using fascias or synthetic materials. Bioabsorbable scaffold has also been used as an optional patch material for rotator cuff regeneration due to its beneficial characteristics, which include a high affinity for living organisms, augmentation by newly formed extracellular matrices after degradation, and no threat of disease transmission1. Several studies detailing rotator cuff regeneration using cultured cells, such as mesenchymal stem cells or fibroblasts, have been reported, however these methods require two step surgeries that firstly harvest the stem cells, and then transplant the cells2. We previously produced novel poly (DL-lactide-co-glycolide) (PLG) scaffolds using electrospinning method and revealed its use in a rabbit osteochondral defect model3. In this study, the PLG scaffold was transplanted into rotator cuff defect and evaluated in a rabbit model.

Materials and Methods
Preparation of scaffolds The biodegradable polymeric scaffolds composed of PLG (glycolide ratio 50:50) were used (TEIJIN Limited, Japan). The PLG scaffold was fabricated with electrospinning method. In electrospinning, synthetic ultra-fine polymer fiber ranging from 200 nm to 800 nm in diameter were fabricated in a high-voltage electron field. The porosity of each scaffold was 85±0.8 % (Fig 1a,b).

Mechanical evaluation The ultimate failure load of scaffold-humeral head complex was 28.1N at 4weeks postoperatively, 71.7N at 8 weeks and 75.3N at 16 weeks, respectively (Fig 4a). There was no statistical difference between normal infraspinatus tendon and 8, 16 postoperative groups. The stiffness of scaffold-humeral head complex was 6.1N/mm at 4 weeks, 9.8 N/mm at 8 week and 12.8N/mm at 16 weeks, respectively (Fig 4b). Stiffness at each time point was significantly less than that of normal infraspinatus tendon.

Discussion
A combination of scaffolds, cells, and growth factors has been used in successful tissue regeneration4. The novel PLG scaffold had a potential for regeneration of osteochondral defect without using exogenous growth factors and cultured cells5. In this study, the PLG scaffold was transplanted in rotator cuff defect. Histologically, the enthesis pattern and expression of type II collagen was observed in the scaffold bone interface. Mechanically, the regenerated tissue showed sufficient ultimate failure load. Thus, this technique might enable surgeon to repair massive rotator cuff tear via a single surgery without using exogenous growth factors or cultured cells.

Figure 1
(a) SEM of scaffold
(b) macroscopic appearance of scaffold
(c) scheme of operation

Figure 2
scaffold bone interface at postoperative

Figure 3
Immunostaining of scaffold bone interface at 16 weeks

Figure 4
Result of mechanical examination

References

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