

RESEARCH

**Repair of rotator cuff injuries using different
composites[☆]**



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KEYWORDS

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Abstract

Aim: Rotator cuff repairs have shown a high level of re-ruptures. It is hypothesised that the use of rhBMP-2 in a carrier could improve the biomechanical and histological properties of the repair.

Material and methods: Controlled experimental study conducted on 40 rats with section and repair of the supraspinatus tendon and randomisation to one of five groups: Group 1 (control) only suture; Group 2 (double control), suture and alginate-chitin carrier; Group 3 (alginate-control), the rhBMP-2 was added to the alginate; Group 4 (chitin-control), application of the rhBMP-2 to the chitin; and Group 5 (double sample): the two components of the carrier (alginate and chitin) have rhBMP-2. A biomechanical and histological analysis was performed at 4 weeks. *Results:* A gap was observed in all cases 4 weeks after supraspinatus detachment. The re-rupture rate was 7.5%, with 20% of them in the control-alginate group. Histologically the best results were obtained in the double sample group: 4.5 (3.3–5.0). Double sample were also able to support higher loads to failure: 62.9 N (59.8–69.4) with lower rigidity 12.7 (9.7–15.9).

Conclusions: The use of alginate-chitin carrier with rhBMP-2 improves the biomechanical and histological properties of the repair site in a chronic rotator cuff tear.

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PALABRAS CLAVE

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Reparación de las lesiones crónicas del manguito rotador mediante diferentes compuestos

Resumen

Objetivo: La reparación del manguito rotador se acompaña de una elevada tasa de rerrotura. Nuestro objetivo es determinar si el empleo de rhBMP-2 vehiculizada en un transportador híbrido mejora el proceso de reparación en lesiones crónicas del manguito.

Material y métodos: Estudio experimental en 62 ratas. A las 4 semanas de la lesión se llevó a cabo una sutura transósea y la asignación aleatoria a uno de los 5 grupos de estudio: 1) grupo control: solo sutura; 2) grupo doble-control: se aplicó además un transportador de alginato-quitina; 3) grupo control-alginato: se añadió rhBMP-2 al alginato; 4) grupo control-quitina: se añadió rhBMP-2 a la quitina, y 5) grupo doble-muestra: se añadió rhBMP-2 a ambos componentes. A los 4 meses se evaluaron los resultados mediante estudios biomecánicos e histológicos.

Resultados: En todos los casos se observó una brecha osteotendinosa macroscópicamente a las 4 semanas. La tasa de rerrotura fue del 7,5%, ocurriendo el 20% de ellas en el grupo control-alginato. En la evaluación histológica los mejores resultados se obtuvieron en el grupo doble muestra: 4,5 (3,3-5). La carga máxima soportada fue mayor en el grupo doble muestra 62,9 N (59,8-69,4) presentando además una menor rigidez 12,7 (9,7-15,9).

Conclusiones: El empleo de la rhBMP-2 vehiculizada en un transportador híbrido de alginato-quitina parece mejorar las características histológicas de la reparación e incrementar las propiedades biomecánicas del tendón en el contexto de una lesión crónica del manguito rotador. © 2016 SECOT. Publicado por Elsevier España, S.L.U. Todos los derechos reservados.

Introduction

Shoulder pain is the third most common cause of specialised medical consultation.¹ Rotator cuff tears present in approximately 30% of the population over 60 and up to almost 60% of people over 80. In the United States alone approximately 450,000 operations per year are carried out, entailing direct medical costs of 7 billion dollars.² Although several studies recommend conservative treatment for complete ruptures,³ the most standard treatment is surgical reconstruction. Notwithstanding, despite good clinical outcome, re-rupture percentages following repair range from between 16% and 94% depending on the series,⁴⁻¹⁰ and although clinical outcome after re-rupture are higher than non-suture of a damaged tendon, they are accompanied by a reduction in strength and lower joint balance if compared to a healthy tendon.¹¹

Improved techniques have been developed to reduce the failure rate of repair. They aim to increase the tensile strength of suture, which is linked to both the implant and the suture properties. There are metallic clasps, of re-absorbable materials, thermoplastic polymers, compounds consisting only of sutures, transosseous sutures and all of them have different types of configurations: simple, modified Masson-Allentype, "double-row" configurations (theoretically biomechanically superior, but which have not yet been demonstrated to provide superior functional results).¹² Despite these improvements both in implants and in the technique itself, the percentage of suture failure continues to be high, leading to the search for a different type of strategy to improve said repair. In this regard, tissue engineering may play an essential role.

There are many experimental studies which have used growth factors in the rotator cuff injury restoration process. The group of bone morphogenetic proteins (BMP) are growth factors with more powerful osteo-inductive capacities, and there are several experimental studies which recommend the benefits of these in the treatment of rotator cuff injuries, improving the biomechanical properties and promoting tendon differentiation¹³⁻¹⁶ in others, but this role is not as clear.¹⁷ There are therefore many biomaterials which have been tested in vitro, in test animals or in humans, where the aim is to promote injury repair. The carriers are not only used as passive materials, allowing the surrounding tissue to grow over the injury and acting as a scaffolding for it, but they also play an active part as carriers for growth or cell factors.¹⁸ In short, the biomaterial selection is critical to the success or failure of the tissue engineering procedure development. This study uses the combination of alginate and chitin as growth factor carriers. Both carriers have been extensively used in tissue engineering procedures.¹⁸⁻²¹ These are 2 biocompatible and biodegradable materials whose main advantage as a hybrid carrier is their mechanical superiority with regard to either of the 2 carriers in isolation. Furthermore, unlike the isolated alginate or chitin carriers, the hybrid carrier may be prepared with pH neutral solutions, offering the additional advantage of systematically incorporating proteins or drugs in the centre of their matrix with or without minimum denaturalisation.²²

Our hypothesis is therefore as follows.

The application of rhBMP-2 loaded into the appropriate carrier, within the context of a chronic rotator cuff injury, may contribute to histological and biomechanical

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