Muscular Regeneration After Prosthetic Implants at Abdominal Wall Region in Rabbits

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Abstract. Five female domestic rabbits, aged five months, were surgically approached for implantation of polypropylene prosthetic meshes at abdominal wall level, in a preperitoneal position. After 90 days post-implant, biopsies from implant areas were sampled and processed for histopathological examinations. Microscopic examination revealed processes of muscular regeneration in muscular fascicles from the vicinity of implants, but also in proliferated connective tissue between the implants and muscular fascicles. We believe that myoblasts identified within the muscular fascicles appeared because of satellite cells and those from connective tissue from stem cell existing in the area.

Keywords: muscular regeneration, prosthetic implant, rabbit, satellite cell, stem cell

INTRODUCTION

Skeletal muscle undergoes regeneration in response to injury. Mononucleated cells, known as satellite cells, are located under the basal lamina of the multinucleated muscle fibre. When the fibre is damaged these cells become activated, replicate, and then differentiate to form new fibres, thus permitting muscle repair (Cossu and Sampaolesi, 2004). Experiments with purified satellite cells have demonstrated their efficiency in muscle repair as well as their capacity to self-renew (Collins et al., 2005; Montarras et al., 2005). Beside satellite cells also at reparatory processes of muscle fibers participate stem cells, these being the principal source of regenerating (Jejurikar et al., 2006).

Utilisation of stem cells is becoming a real therapeutic opportunity (Cossu and Sampaolesi, 2004), thanks to effort of some researchers. Much recent works describe different types of stem/progenitor cells that show extended proliferation in vitro and the ability to generate normal muscle fibers when transplanted into a dystrophic muscle (Cossu and Sampaolesi, 2004).

Prosthetic polypropylene meshes are widely used in abdominal wall defects repair in humans and animals (Schumpelick and Klinge, 2003), but because they are not ideal materials, they can generate local and general complications.

The purpose of this experiment was to test, histologically, the regeneration capacity of skeletal muscle after an “injury”, our case, prosthetic polypropylene mesh implant in abdominal region.
MATERIALS AND METHODS

Our observations were been conducted on five female domestic rabbits, aged five months, with an average weight of 2500 g. Rabbits were housed in the same cage and were subjected to surgery in the abdominal ventral region, for experimental implantation of polypropylene prosthetic meshes (preperitoneal position). We did not observed any intra and postoperative complications. After 90 days postoperative, the animals were slaughtered and fragments of tissue from the prothosed area were collected for histopathological investigations. The pieces were fixed in Stieve’s solution for 48 hours, included in paraffin and cuted to 5µm. Sections were stained using Goldner’s Trichrome stain. By examining at optical microscope, reparatory processes from the implant zone were observed, especially in the immediate vicinity of prosthetic biomaterials used.

RESULTS AND DISCUSSION

At 90 days after implantation of biomaterials, their wires were surrounded by connective tissue in the process of proliferation, more or less consolidated, existing sometimes large differences from one area to another. Between the wires of the biomaterials and muscular tissue a zone of connective tissue was interposed, so that muscular tissue does not come into contact with wires of the biomaterials. Adjacent muscular tissue appeared reacted, almost 50% of muscular cells showing processes of degeneration or lysis. In some microscopic fields can be observed alterative-necrotic processes in focal (Fig. 1) of some muscular fibers, areas with coagulation necrosis being characterized by a homogenization and a tumefaction of sarcoplasm, with disappearance of the structure specific to striated skeletal muscle.

In areas with coagulation necrosis in focus, can be observed also the deposition of a proteic material of hyalin (hyalinization of areas with low vitality or with necrosis), hyalinization being with focal aspect such is also the necrosis (Fig. 2).

Besides degenerative or alterative processes of muscular cells, aspects of regeneration have been observed. Inside muscular fascicles, at the periphery of some muscular cells with coagulation necrosis in focus in which basement membrane was not disintegrated, an activation of satellite cells located between the basement membrane and sarcolemma can be observed (Fig. 3).

Thus, these satellite cells increase in size much, their nuclei being large and vesiculous with nucleoli distinguished, these cells generating the myoblasts. In fact, one of the factors of satellite cell activation is muscular necrosis. From a place to another there are different sizes of myoblasts and with many nuclei, often grouped (Fig. 4). There are also thin muscular cells, and sometimes with thin ends, which we believe that are young muscular cells. These aspects suggest the uncoiling of some processes of regeneration of muscular cells, with the starting point satellite cells. Although reparatory processes are present, they run at a level that can not compensate myolysis which still take place at a high rate.
Young muscular cells are present and dispersed in the connective tissue that is interposed between the biomaterial wires and muscular fascicles. These muscular cells are very polymorphous, both as sizes and stage of maturation. After all their aspects, these cells are myoblasts in various stages of maturation. One of the arguments on which we do sustain this affirmation is the very different thickness from one cell to another, but in many cases also at the same cell from one end to another.
Also, these cells appear multinucleated, but nuclei are not disposed throughout the length of the mature muscular cells, but are agglomerated in the central area or towards one of the cell ends (Fig. 5). This latter aspect appear especially in cells which do not have the same thickness throughout their length, nuclei being agglomerated, in such cases, at the thick end, which give the overall appearance of the comet like cells (Fig. 6) or even muscular branched cells (Fig. 7). Most of these cells does not present striations comparable with mature muscular cells from the area. In some cases, relatively large differences exist within the same cell,
meaning that in an end can be observed elongated formations without striations and in the other end, the cell present striations similar somehow with those of mature cell.

The aspects observed show that after surgical intervention reparatory processes are unleashed, materialized mostly by the proliferation of connective tissue and cicatricial tissue. Also development of reparatory processes at muscular component is observed, with the appearance of myoblasts, both inside the muscular fascicles and inside of connective tissue proliferated around wires of biomaterial.

Those from fascicles are running depending of satellite cells, and those from the connective tissue may occur by proliferation of some stem cells from the area. However, in recent years, the role of muscle-derived satellite cells in process of muscular regeneration has been challenged and it has been proposed that cells from other sources such as bone marrow may be contributors of adult muscle stem cells (LaBarge and Blau, 2002).

With decoiling of all these reparatory processes, new cells formed are too few to be able to compensate myolysis, which runs still at relatively high rate. In this context, it appears that the connective tissue in the immediate vicinity of the muscular fascicles will expand to balance the processes of lysis and muscular regeneration.

Numerically, the myoblasts from conjunctive tissue are more numerous than those within muscular fascicles, which makes us believe that, although muscle regeneration is started both by satellite cells and stem cells, in case of postoperative injuries, muscular regeneration is preponderant due to stem cells.

However, in regenerating muscle, the number of myogenic precursors exceeds that of resident satellite cells, implying migration or recruitment of undifferentiated progenitors from other sources (Ferrari et al., 1998).
CONCLUSIONS

After polypropylene prosthetic implant of biomaterials in the rabbit abdominal wall, muscular lesions, moderate in intensity appear, but they are accompanied by phenomena of muscular regeneration that is trying to replace the compromised muscular cells.
Processes of muscular regeneration from inside of muscular fascicles have as the starting point the satellite cells and those from the connective tissue proliferated in the implant areas have as a starting point the stem cells.

The young muscular cells proliferated in the connective tissue from the implant areas are more numerous than those from inside of muscular fascicles, which is why we believe that postoperative muscular regeneration is primarily due to stem cells and only secondly due to satellite cells.

REFERENCES