Muscle Injury Rehabilitation Through Peptide Therapy

Simranjot Pandher and Dr. Hannah Baughman
Division of Sciences & Mathematics, University of Washington | Tacoma, Tacoma, WA 98402

ABSTRACT

Muscle injuries, such as soft tissue tears or tendon and ligament tears, can be one of the most common injuries amongst professional athletes and can often be career-ending injuries that come with a lifetime of complications. Currently, the most common form of treatment for such injuries is surgical interventions followed up with physical therapy (PT). However, surgery is often followed by long recovery periods. To improve surgical outcomes, PT is often recommended, which presents its own set of limitations. PT results vary for every patient, factors such as age and patient determination play a large role in recovery time periods and results. Given the limitations of existing treatment methods, it's important to develop alternative options with shorter recovery times. This review looked at peptide therapy as a form of alternative treatment. Peptides are chains of amino acids and have many applications, including hormone treatments. This review focuses on select peptides that have been used for their therapeutical potentials with muscle regeneration and rehabilitation in primary scientific studies. It was found that peptide therapy through the likes of BPC-157, Peptide Nanofibers, MIF1 and MIF2 myostatin, and Melittin has clinical support in their potential to aid in muscle regeneration and rehabilitation in animal studies. Future research directions should focus on conducting rigorous human clinical trials to evaluate the safety, efficacy, and long-term outcomes of peptide based therapies.

METHODS

Research involved analyzing various sources for each peptide. Papers were considered for this research if they were primary sources and involved direct experimentation in the papers. The studies used in this research included those that involved experimentation of peptide therapy for muscle regeneration.]Studies included those on BPC-157, Laminin-Mimetic Bioactive Peptide Nanofibers, MIF1 and MIF2 myostatin, and Melittin. These peptides were explored for their potential in treating injuries in mice. Specifically, in these studies, experiments were conducted where various muscle injuries were induced in mice, followed by treatment with peptide therapy to assess its effectiveness in healing the injuries.

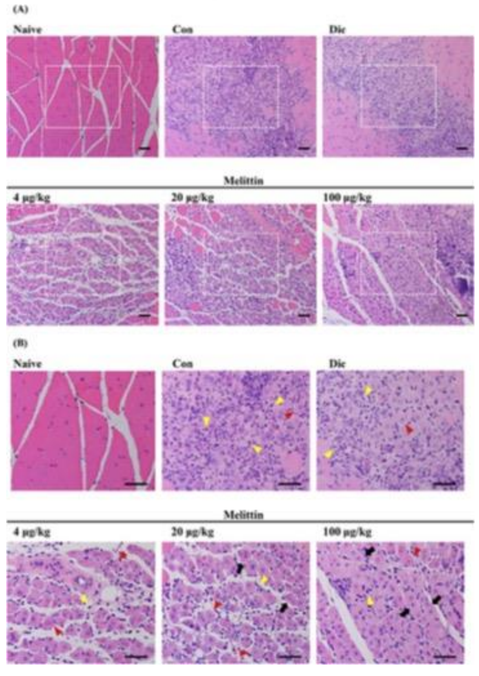
References

Myostatin Inhibitors MIF1 and MIF2

- Effects of myostatin inhibitory peptides MIF1 & MIF2 on myoblast proliferation, differentiation, and muscle regeneration were studied by Lee et al. (2022)
- Male Wistar Albino rats were administered MIF peptides, and results showed enhanced myoblast proliferation and differentiation, as well as increased expression of myogenic marker genes.
- According to the authors, the research demonstrates that Ac-MIF1 and Ac-MIF2-NH2 peptides promote myogenesis, facilitate the regeneration of injured muscles, and decrease adipogenic proliferation and differentiation by suppressing the expression of adipogenic marker genes.

Melittin for Muscle Regeneration

- Lee et al. (2019) investigated melittin, a component of bee venom, for its therapeutic effects on muscle regeneration in a mouse model with induced muscle contusion.
- Melittin treatment improved locomotor activity and treadmill running activity.
- The improvement was dose-dependent and comparable to the effects of diclofenac, a medication for inflammation and pain.

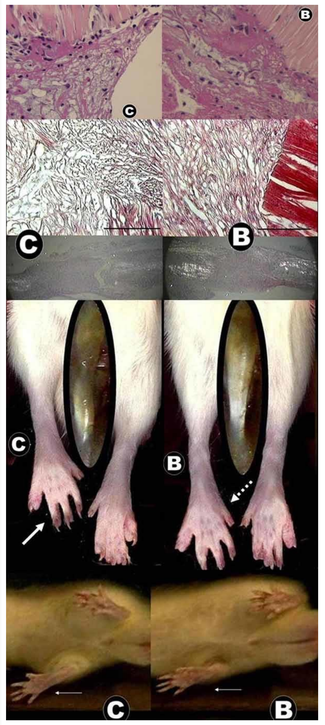


Histological analysis revealed morphological improvements in muscle tissue, suggesting enhanced muscle regeneration and functional recovery.

- The study suggests melittin has potential as a therapeutic agent for muscle injury treatment due to its anti-inflammatory effects and ability to promote muscle regeneration.

Gastric Pentadecapeptide BPC 157

- Novinscak et al. (2008): Studied BPC 157 in muscle crush injuries in rats.
  - Findings: Improved muscle healing, reduced scar formation, decreased serum enzyme levels.
  - Rats treated with BPC 157 showed accelerated muscle regeneration and reduced scar formation.
- Staresinic et al. (2006): Investigated BPC 157 on transected quadriceps muscle in rats.
  - Findings: Prompt functional and biomechanical improvement, better muscle healing quality over time.
- Cerovecki et al. (2010): Studied BPC 157 in ligament healing post-MCL surgical transection in rats.
  - Findings: Promoted organized connective tissue formation, particularly collagen fibers, reduced inflammation.
  - BPC 157 is suggested as a promising therapeutic agent for ligament injuries.

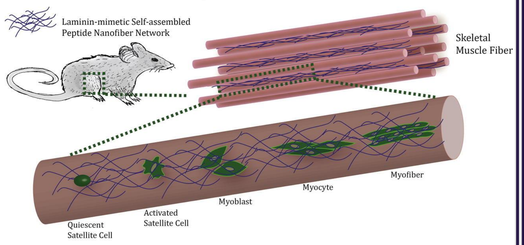


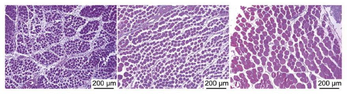
The figure to the right shows Cerovecki's findings:
Top: Microscopic images of ligament healing at day 2 after surgery in rats treated with BPC 157 (right) and control rats (left). Control rats show more inflammation, while BPC 157-treated rats have less.
Middle: Images at day 7 post-surgery show better collagen organization and less tissue inflammation in BPC 157-treated rats (B) compared to controls (C).
Bottom: At day 28 post-surgery, control rats have leg contracture, while BPC 157-treated rats do not. BPC 157-treated rats also show better walking ability and stability.

- Krivic et al. (2006): Investigated BPC 157 on Achilles tendon-to-bone healing in rats.
  - Findings: Improved functional, biomechanical, macroscopic, histological, and immunohistochemical healing parameters compared to control groups.

Laminin-Mimetic Bioactive Peptide Nanofibers

- Laminins serve as essential building blocks for cellular networks.
- Physical bridges between intracellular and extracellular compartments. (Monique, 2012)
- Laminins contribute to the formation and regulation of basement membranes. (Sanes, 2003)
- These membranes govern the architecture and physiology of tissues
- Presence of Laminins in basal membrane suggest laminins as a potential approach for promoting skeletal muscle regeneration.





Histological examination revealed thicker muscle cross-sectional areas in the peptide nanofiber-treated group, indicating improved muscle regeneration. Furthermore, gene expression analysis showed early activation of satellite cells and myogenic differentiation in the peptide nanofiber-treated group, suggesting a mechanism for enhanced muscle repair. (Cimenci et al., 2017)

PRELIMINARY CONCLUSIONS

Through the exploration of various peptides, including laminin-mimetic bioactive peptide nanofibers, myostatin inhibitors MIF1 and MIF2, melittin, and gastric pentadecapeptide BPC 157, compelling evidence has been presented regarding their effectiveness in promoting musculoskeletal regeneration in preclinical studies. However, it is important to acknowledge the limitations of current research, particularly the lack of human studies evaluating the efficacy and safety of peptide-based therapies. While findings from animal models provide valuable insights, further research is needed to validate these findings in human populations and to optimize treatment protocols. Looking ahead, future research directions should focus on conducting rigorous human clinical trials to evaluate the safety, efficacy, and long-term outcomes of peptide-based therapies.