



Emerging Therapies in the Treatment of Carpal Tunnel Syndrome

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Abstract

Carpal Tunnel Syndrome (CTS) is a prevalent condition caused by compression of the median nerve at the wrist, leading to symptoms such as pain, numbness, tingling, and weakness in the hand. While traditional treatments like corticosteroid injections, wrist splinting, and surgical decompression have been widely used, emerging therapies are gaining attention for their potential to provide effective alternatives, particularly for patients who do not respond well to conventional approaches. This review explores the latest advancements in the treatment of CTS, including platelet-rich plasma (PRP) therapy, nerve hydrodissection, ultrasound-guided injections, stem cell therapy, and laser therapy. Early studies suggest that these therapies may offer long-term relief, improve nerve function, and reduce inflammation, with fewer side effects compared to traditional treatments. The mechanisms of action for each therapy, patient selection, and clinical outcomes are discussed, along with the potential benefits and challenges. Although promising, more robust, large-scale studies are required to determine the efficacy, safety, and long-term benefits of these emerging therapies. This article provides an overview of the current state of emerging treatments and highlights their potential to revolutionize the management of Carpal Tunnel Syndrome in the coming years.

Keywords: Carpal tunnel syndrome; Emerging therapies; Platelet-rich plasma (PRP); Nerve hydrodissection; Stem cell therapy; Ultrasound-guided injections

Introduction

Carpal Tunnel Syndrome (CTS) is a common neurological disorder resulting from compression of the median nerve as it passes through the carpal tunnel in the wrist [1]. This condition leads to symptoms such as pain, numbness, tingling, and weakness in the hand and fingers, which can significantly impair daily activities and quality of life [2-4]. CTS is often caused by repetitive hand movements, but other risk factors include pregnancy, diabetes, obesity, and genetic predisposition. While conservative treatments such as wrist splinting, physical therapy, and corticosteroid injections are typically effective for mild to moderate cases, surgical decompression is often required for severe or persistent symptoms.

In recent years, there has been growing interest in emerging therapies for CTS, particularly for patients who do not respond to traditional treatments or seek alternatives to surgery. These innovative treatments aim to address the underlying causes of nerve compression, reduce inflammation, and promote nerve healing [5]. Among the most promising emerging therapies are platelet-rich plasma (PRP) therapy, nerve hydrodissection, stem cell therapy, and ultrasound-guided injections, each offering potential advantages over conventional treatments. Platelet-rich plasma (PRP) therapy utilizes the body's own platelets to accelerate tissue repair and reduce inflammation, while nerve hydrodissection involves the use of saline or local anesthetics to gently separate the compressed nerve from surrounding tissues. Stem cell therapy holds the potential to regenerate damaged tissues and promote long-term nerve healing, while ultrasound-guided injections offer more precise delivery of therapeutic agents [6]. Despite the promise these treatments show in early studies, clinical evidence on their long-term effectiveness and safety remains limited. This article aims to review the current state of emerging therapies in the treatment of CTS, focusing on their mechanisms of action, clinical outcomes, and potential to revolutionize the management of this common and often debilitating condition. Through exploring these novel approaches, we aim to provide a comprehensive understanding of how these therapies may complement or replace traditional treatments, offering patients more effective and minimally invasive options for managing Carpal

Tunnel Syndrome.

Results and Discussion

Platelet-rich plasma (PRP) therapy has gained attention as a potential treatment for Carpal Tunnel Syndrome (CTS) due to its ability to promote tissue healing and reduce inflammation. PRP is derived from the patient's own blood, processed to concentrate platelets, growth factors, and cytokines, which are then injected into the affected area. Several studies have demonstrated that PRP can reduce inflammation and stimulate nerve regeneration, resulting in improved symptoms for patients with CTS [7]. One of the major advantages of PRP therapy is its minimal risk of adverse effects, as the material is autologous (derived from the patient's own blood). Nonetheless, PRP therapy is still considered an experimental treatment, and more large-scale, randomized controlled trials are needed to confirm its long-term efficacy and establish standardized protocols for its use in CTS. Nerve hydrodissection is a technique that involves the injection of a solution, such as saline or local anesthetics, around the compressed nerve. The goal is to separate the median nerve from the surrounding tissues and reduce the mechanical pressure on the nerve, thereby improving symptoms. Preliminary studies and case reports have shown that nerve hydrodissection can be a safe and effective option for patients with CTS, especially in those who have not responded well to conservative treatments. While promising, nerve hydrodissection is still an emerging technique, and further studies are required to determine its long-term effectiveness, particularly in comparison to other treatments such as corticosteroid injections and surgery. One limitation of the technique is the potential for nerve injury if the injection is not performed correctly,

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making the need for skilled practitioners and appropriate imaging guidance crucial. Stem cell therapy has emerged as an innovative approach for regenerating damaged tissues and promoting healing in CTS. Stem cells, typically derived from bone marrow or adipose tissue, are injected into the carpal tunnel to promote nerve regeneration and tissue repair. Early studies have shown promising results, with patients reporting significant reductions in pain and improvements in nerve conduction following stem cell injections.

Patients with moderate to severe CTS who received stem cell injections showed significant improvements in both clinical outcomes (pain relief, functional recovery) and electrodiagnostic findings (improvement in nerve conduction velocities) [8]. However, stem cell therapy is still in the early stages of clinical application for CTS, and larger, well-designed studies are needed to assess its safety, efficacy, and long-term outcomes. A key benefit of stem cell therapy is its potential for nerve regeneration and long-lasting effects, which could provide a solution for patients with chronic CTS or those with nerve damage that is unresponsive to traditional treatments. Nonetheless, the procedure is complex, expensive, and involves a risk of complications such as infection or tumor formation, which necessitates careful consideration and further research before it becomes a mainstream treatment option. Ultrasound-guided injections offer improved precision for delivering corticosteroids or other therapeutic agents directly to the site of compression in the carpal tunnel. Studies have shown that ultrasound guidance improves the accuracy of injections and may reduce the risk of complications compared to traditional blind injection techniques. Ultrasound guidance allows for real-time visualization of the median nerve, the surrounding structures, and the distribution of the injected substance, enhancing the therapeutic effect [9].

The emerging therapies for Carpal Tunnel Syndrome, including PRP therapy, nerve hydrodissection, stem cell therapy, and ultrasound-guided injections, offer promising alternatives to traditional treatment methods. While these therapies provide benefits in terms of pain relief, nerve function improvement, and minimally invasive approaches, many are still in the early stages of clinical investigation. Long-term efficacy, safety profiles, and cost-effectiveness need to be fully established through large-scale, randomized controlled trials before they can be considered standard practice. Importantly, these therapies are not likely to replace traditional treatments such as corticosteroid injections or surgical decompression, but rather complement them, offering more personalized treatment options for patients with chronic, severe, or non-responsive CTS. Additionally, these therapies highlight the growing trend toward more minimally invasive, regenerative, and precision-based approaches to managing CTS, which may offer patients better long-term outcomes with fewer side effects. Emerging therapies in the treatment of Carpal Tunnel Syndrome provide exciting alternatives to traditional methods, potentially improving outcomes, reducing complications, and offering non-surgical solutions for patients with chronic or severe CTS [10]. While promising, these therapies require further validation through robust clinical trials to determine their safety, effectiveness, and long-term viability. Until such data is available, clinicians should continue to rely on well-established treatments, with emerging therapies serving as an additional option for select patients who may benefit from them.

Conclusion

Emerging therapies for Carpal Tunnel Syndrome (CTS) offer promising alternatives and enhancements to traditional treatment options, including corticosteroid injections and surgical decompression. Platelet-rich plasma (PRP) therapy, nerve hydrodissection, stem cell therapy, and ultrasound-guided injections are gaining attention for their potential to reduce inflammation, improve nerve function, and provide long-term relief with fewer side effects compared to conventional approaches. While early studies show positive results, these therapies are still in the experimental stages and require further large-scale clinical trials to confirm their efficacy, safety, and long-term benefits. The ability to provide minimally invasive treatments, personalized care, and targeted approaches makes these therapies a valuable addition to the armamentarium for CTS management, particularly for patients who do not respond well to traditional methods. However, they are unlikely to replace conventional treatments entirely but can serve as complementary options for patients with chronic or severe CTS. As research progresses, emerging therapies may offer significant advantages in improving patient outcomes, reducing recovery times, and minimizing the risks associated with more invasive procedures. Until then, these therapies should be considered as part of a broader, individualized treatment plan for Carpal Tunnel Syndrome, while keeping in mind the need for further validation and standardization in clinical practice.

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Conflict of Interest

None

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