

Peptide Therapy in Aesthetic, Metabolic, and Endocrine Medicine

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Abstract: *Therapeutic peptides have emerged as promising agents in aesthetic, metabolic, and endocrine medicine due to their high specificity, favourable biological activity, and expanding clinical applications. In aesthetic medicine, peptides are increasingly used for skin rejuvenation, collagen stimulation, wound healing, and hair restoration. In metabolic disorders, peptide-based therapies such as glucagon-like peptide-1 receptor agonists have demonstrated significant benefits in weight reduction and glycaemic control. In endocrine conditions, peptide analogues are widely employed in the management of growth hormone deficiency, reproductive disorders, and other hormone-related abnormalities. This review summarizes the mechanisms of action, key peptide molecules, routes of administration, clinical applications, safety considerations, and future prospects of therapeutic peptides in these fields. However, limitations such as short half-life, variable bioavailability, and the need for long-term safety data remain important considerations. Continued research and well-designed clinical trials are necessary to optimize peptide-based therapies and expand their evidence-based use across multiple medical specialties.*

Keywords: Therapeutic peptides, aesthetic medicine, metabolic disorders, endocrine disorders, peptide therapy, GLP-1 receptor agonists, collagen stimulation, routes of administration, safety profile

1. Introduction

Therapeutic peptides are short chains of amino acids that exert biological effects through interaction with specific receptors or signalling pathways. Their ability to mimic endogenous hormones and regulatory molecules has led to their increasing use in clinical medicine. In recent years, peptides have gained substantial attention in aesthetic, metabolic, and endocrine fields because of their potential to provide targeted treatment with reduced systemic adverse effects compared with some conventional therapies.

In aesthetic medicine, peptides are incorporated into injectable therapies, topical formulations, and regenerative protocols aimed at improving skin quality, elasticity, and tissue repair. Metabolic medicine has witnessed major advances with the development of peptide-based agents for obesity and type 2 diabetes management. Similarly, endocrine medicine has long utilized peptide hormones and analogues for the treatment of growth disorders, infertility, and other hormonal conditions.

2. Mechanisms of Action

Therapeutic peptides act through several biological mechanisms:

- **Receptor binding:** Many peptides exert their effects by binding to specific cell-surface receptors and activating intracellular signalling pathways.
- **Hormonal modulation:** Peptide analogues can mimic or regulate endogenous hormone activity, influencing metabolism, growth, and reproductive function.
- **Tissue regeneration:** Certain peptides stimulate collagen synthesis, angiogenesis, and cellular repair, making them valuable in aesthetic and wound-healing applications.
- **Metabolic regulation:** Peptides such as GLP-1 receptor agonists enhance insulin secretion, suppress appetite, and improve glucose homeostasis.

3. Key Therapeutic Peptide Molecules

Aesthetic Medicine

- **Copper peptides (GHK-Cu):** Promote collagen synthesis, wound healing, and antioxidant activity. Commonly used in topical formulations and regenerative aesthetic protocols.
- **Palmitoyl pentapeptide-4:** Stimulates extracellular matrix production and supports reduction of fine lines and wrinkles. Primarily used in topical anti-aging products.
- **Acetyl hexapeptide-8:** A neuromodulating cosmetic peptide used in topical formulations aimed at reducing the appearance of dynamic facial lines.
- **Thymosin beta-4 and related regenerative peptides:** Investigated for tissue repair, wound healing, and hair follicle support.

Metabolic Medicine

- **Semaglutide:** A GLP-1 receptor agonist used for obesity management and type 2 diabetes mellitus. It improves glycaemic control and promotes weight reduction.
- **Liraglutide:** Another GLP-1 receptor agonist with established roles in diabetes management and chronic weight management.
- **Tirzepatide:** A dual GIP and GLP-1 receptor agonist showing significant effects on weight reduction and glycaemic control.
- **Exenatide:** A GLP-1 receptor agonist used in the management of type 2 diabetes mellitus.

Endocrine Medicine

- **Growth hormone-releasing peptides (GHRPs):** Stimulate endogenous growth hormone secretion and are investigated in selected endocrine and regenerative contexts.
- **Gonadotropin-releasing hormone (GnRH) analogues:** Used in reproductive endocrinology, infertility treatment, and management of hormone-sensitive conditions.
- **Somatostatin analogues:** Such as octreotide and lanreotide, used in acromegaly and neuroendocrine tumour management.

- Parathyroid hormone analogues: Such as teriparatide, used in osteoporosis treatment.

Routes of Administration

Route	Examples	Clinical Considerations
Subcutaneous injection	Semaglutide, liraglutide, tirzepatide, GHRPs	Most common route for systemic peptide therapy; provides reliable absorption.
Intramuscular injection	Selected hormone analogues and regenerative peptide protocols	Used when slower absorption or depot effect is desired.
Intravenous administration	Limited specialized clinical or research applications	Provides rapid systemic delivery but requires professional supervision.
Topical administration	GHK-Cu, palmitoyl pentapeptide-4, acetyl hexapeptide-8	Common in aesthetic formulations for localized skin effects.
Oral administration	Oral semaglutide	Represents an important advancement, though peptide stability and absorption remain challenges.
Intranasal administration	Selected experimental or hormone-related peptide formulations	Offers a non-invasive route but has variable bioavailability.

Advantages and Limitations of Administration Routes

- Subcutaneous administration is favoured for many metabolic and endocrine peptides because it bypasses gastrointestinal degradation and allows sustained systemic exposure.
- Topical administration is particularly useful in aesthetic medicine for localized effects on skin rejuvenation and wound healing, although penetration through the skin barrier may limit bioavailability.
- Oral peptide delivery is convenient for patients, but many peptides are susceptible to enzymatic degradation and poor gastrointestinal absorption.
- Injectable routes generally provide more predictable pharmacokinetics but may reduce patient adherence due to needle-related discomfort or injection-site reactions.

1) Clinical Applications in Aesthetic Medicine

Skin Rejuvenation

Peptides such as copper peptides and matrix-stimulating peptides may enhance collagen production, improve skin elasticity, and reduce the appearance of fine lines and wrinkles.

Wound Healing and Tissue Repair

Bioactive peptides can promote fibroblast activity, angiogenesis, and extracellular matrix remodelling, supporting faster wound healing and improved tissue recovery.

Hair Restoration

Certain peptide formulations are being explored for their potential to stimulate hair follicle activity and improve hair density in androgenetic alopecia and other hair-loss conditions.

2) Clinical Applications in Metabolic Disorders

Obesity Management

GLP-1 receptor agonists have shown substantial efficacy in reducing body weight by suppressing appetite and delaying gastric emptying.

Type 2 Diabetes Mellitus

Peptide-based therapies improve glycaemic control by enhancing glucose-dependent insulin secretion and reducing glucagon release.

Metabolic Syndrome

Emerging peptide therapies are being investigated for their potential role in improving insulin sensitivity, lipid metabolism, and inflammatory markers associated with metabolic syndrome.

3) Clinical Applications in Endocrine Disorders

Growth Hormone Deficiency

Growth hormone-releasing peptides and analogues are used to stimulate growth hormone secretion in selected endocrine conditions.

Reproductive Endocrinology

Peptide hormones such as gonadotropin-releasing hormone analogues play an important role in fertility treatment and the management of hormone-sensitive conditions.

Other Hormonal Disorders

Peptide-based therapies are also used in conditions involving dysregulated hormonal signalling, including certain pituitary and hypothalamic disorders.

Safety Considerations

Although therapeutic peptides are generally considered safe when prescribed appropriately, safety monitoring remains essential.

- Common adverse effects: Injection-site reactions, nausea, gastrointestinal discomfort, headache, and transient fatigue may occur depending on the peptide used.
- Metabolic and endocrine effects: Peptides affecting hormonal pathways may alter glucose metabolism, appetite, or endocrine balance and should be used with careful patient selection.
- Long-term safety: Evidence regarding prolonged use of some newer peptide therapies is still evolving, highlighting the need for post-marketing surveillance and long-term clinical studies.
- Product quality: The safety of peptide therapy also depends on the quality, purity, and regulatory approval status of the formulation used.

4. Future Perspectives

Advances in peptide engineering are expected to improve the stability, bioavailability, and targeted delivery of peptide therapies. Novel peptide formulations may expand applications in regenerative medicine, personalized metabolic treatment, and endocrine disease management. Combination therapies integrating peptides with other pharmacological or regenerative approaches may further enhance clinical

outcomes. However, standardized treatment protocols and robust clinical evidence will be necessary to establish the optimal role of peptides in these fields.

5. Conclusion

Therapeutic peptides represent a rapidly expanding class of biologically active agents with significant potential in aesthetic, metabolic, and endocrine medicine. Their targeted mechanisms of action provide opportunities for effective treatment in skin rejuvenation, obesity management, diabetes care, and hormone-related disorders. While current evidence supports their clinical utility and generally favourable safety profile, continued research is required to clarify long-term efficacy, safety, and optimal treatment protocols. With ongoing scientific advancement, peptide-based therapies are likely to play an increasingly important role in personalized and regenerative medicine.

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