



Biomaterial-based therapeutic strategies for obesity and its comorbidities

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Abstract

Obesity is a global public health problem that leads to many complications and comorbidities such as type 2 diabetes, cardiovascular disease and fatty liver. Drug therapy alone or in combination with lifestyle changes or surgery represent a major modality for combating obesity and its complications. However, most anti-obesity drugs are limited by bioavailability, target specificity, and potential toxic effects. Currently, only a handful of drugs, such as orlistat, liraglutide, and semaglutide, are approved for clinical treatment of obesity. Therefore, there is an urgent need for alternative treatment strategies [1]. Based on new knowledge of the etiology of obesity and efforts to integrate materials, chemistry, biotechnology, and pharmacies interdisciplinary, several new obesity treatment strategies are gradually entering the field of preclinical and clinical research.

INTRODUCTION

Obesity can have some short-term adverse effects on physiologic function, including hypercholesterolemia, hypertriglycerides, insulin resistance, and increased peripheral vascular resistance. More seriously, by tracking obese children and adolescents to adulthood, it has been found that obesity can cause a variety of complications such as type 2 diabetes (T2D), hypertension, and cardiovascular disease. Masu [2]. In addition, obesity also increases the incidence of tumors such as the prostate, uterus, and breast cancer. Based on etiology and etiology, obesity can be easily divided into simple obesity and pathological obesity. Simple obesity is associated with a poor lifestyle. On the one hand, people in this group eat too many fat and high-calorie foods. On the other hand, they lead a sedentary lifestyle and lack of exercise, leading to the accumulation of fat throughout the body.

Biomaterial support anti-obesity therapy:

The evolution of materials science has laid the foundation for the development of biomedical materials. Manufactured from a variety of materials such as lipids, polymers, metals and non-metal inorganic compounds (silica, graphene, etc).

Drug delivery platform is systematically applied to therapeutic studies of various diseases such as cardiovascular disease, neurodegenerative disease, cancer and autoimmunity. Etc [3,4]. These systems not only can deliver various types of drugs such as chemicals, proteins, nucleic acids in a controlled manner, but also promote the effective accumulation of drugs at the target site, thereby enhancing the therapeutic effect. Reduces toxic side effects. This review focuses primarily on the application of biomaterials in the treatment of obesity and its comorbidities. The main treatment strategies involved are Fighting obesity due to the unique properties of certain materials. For example, drug stability and drug delivery by physical loading on nanoparticles, hydrogels, transdermal microneedles [5,6] etc.

Biomaterials for treating obesity Encapsulated phytochemicals

A wide range of natural products featuring various structures, relatively high activity, and mild side effects, where phenolic acids, flavonoids, terpenoids, alkaloids, and other natural products stand out, are valuable information for the development of anti-obesity drugs [6]. It can be a source. It has the potential for anti-obesity.

Biological agents to treat obesity: Many biological agents, such as peptides, miRNAs, and cytokines, have the ability to suppress the development of inflammation, regulate lipid metabolism, and regulate glucose uptake. For example, interleukins IL-4 and IL-10 induce an increase in M2 macrophages and a decrease in the secretion of inflammatory cytokines. Apoptosis-promoting peptide KLA disrupts cellular mitochondrial function, resulting in the release of cytochrome c and the induction of apoptosis. The bioactive peptide PDBSN can inhibit adipocyte differentiation, and miRNA drugs such as miR33 and miR-130b can regulate lipid metabolism. However, all of these biopharmaceuticals face in vivo stability and targeting issues. To address this issue, researchers can bind small molecule drugs to polymers or apply carrier materials such as liposomes and polymer scaffolds to extend the half-life of the drug, drug release profile, absorption and distribution [7]. We have improved the use and safety of drugs by changing such things. AT as a really perfect goal for weight problems remedy.

Formerly notion to be an inert fats garage organ, the adipose tissue (AT) has been diagnosed as an endocrine organ that performs a vital function with inside the frame's homeostasis. It bills for much less than 30 and as much as 80% of general frame weight mass in lean and overweight people, respectively. There are most important styles of ATs, that vary of their feature and anatomical location, namely, the brown adipose tissue (BAT) and the white adipose tissue (WAT) [8]. The BAT is placed specially with inside the intrascapular or supraclavicular region. Intrascapular BAT is ample in rodents and hibernating animals. In people, BAT is greater outstanding in new child toddlers and adults with excessive metabolic rates. Human BAT feature is excessive in newborns, and diminishes with age and elevated frame weight. The electricity expenditure in BAT is promoted via way of means of excessive ranges of uncoupling protein (UCP)-1 in brown adipocytes. BAT is an electricity dissipating organ this is chargeable for adaptive thermogenesis. It preserves homeostasis via way of means of uncoupling oxidative metabolism from ATP manufacturing on the way to produce warmth through UCP-1 for the duration of bloodless exposure. The current identity of BAT in grownup people has sparked hobby to discover it for weight problems remedy [8].

Targeted Nano therapy for remedy of weight problems

Pharmacotherapy nevertheless stays a place of ongoing studies in look for a magic anti-weight problems drug with a purpose to have sizeable and sustainable weight reduction consequences. Since the creation of thyroid hormone because the first anti-weight problems drug in 1893, maximum of the medication that observed had been withdrawn because of their negative facet consequences in overweight patients. Thus, severe warning is obligatory earlier than thinking about any pills for the remedy of weight problems. In addition to the drug's efficacy, its

protection profile is similarly as important. In current years, experimental centered remedy has been said to sell extensive weight reduction with decreased facet consequences in animal fashions of weight problems [9]. These anti-weight problems consequences have been stronger via way of means of the use of nanotechnology-primarily based totally transport systems. Three nano-primarily based totally techniques that targeted at the WAT and its vasculature as a goal for weight problems healing intervention.

Nano-based drug formulations in clinical practice

Nano-primarily based totally drug formulations in scientific practice Nano medicine refers back to the software of Nano science and nanotechnology in scientific sciences, for remedy, analysis and imaging purposes. A wide variety of Nano-primarily based totally formulations are both to be had for human use as FDA-authorized medicines, or present process specific levels of human scientific trial. By 2016, already fifty one FDA-authorized Nano therapies have been to be had even as seventy seven Nano products have been in scientific trials [10]. Majority of those Nano products contained tablets formerly authorized through the FDA. In precept a few of the Nano drugs are designed as encapsulations of FDA authorized tablets in biodegradable and biocompatible NPs along with liposomes, micelles or polymeric NPs. Inorganic or metal nano materials along with AuNPs, iron oxide, silica etc., are nonetheless in section I-III scientific trials [11]. The loss of facts at the destiny of metal NPs in vivo might be the purpose why there may be a put off of their translation and transition into scientific medication. Metallic NPs are non-biodegradable in nature; their capacity to by skip thru cell additives increases fitness concerns.

Nano medicines had been available in the marketplace due to the fact 1990 for remedy of diverse sicknesses along with most cancers, excessive mixed immunodeficiency sickness, and arthritis. Most of the Nano formulations are comprised of medicine presently used clinically for sickness remedy. The tablets are encapsulated in the nanomaterial to enhance their pharmacokinetic properties [12,13]. Some of the Nano drugs already available in the marketplace are indexed in . The earliest software of Nano medicine became in most cancers remedy, wherein liposomes have been used to supply chemotherapeutic payloads to the tumor site. Doxil and Abraxane are the primary FDA-authorized chemotherapeutic Nano drugs in 1995 and 2005, respectively. Abraxane, an albumin-certain paclitaxel NP formulation, became authorized for remedy of metastatic breast most cancers with inside the United States of America (USA) and confirmed extra efficacy with an advanced protection profile than unfastened paclitaxel.

Biomaterial-Assisted Anti-Obesity Therapy

The evolution of substances technological know-how has laid the muse for the improvement of biomedical substances. Drug shipping systems organized from

numerous substances, along with lipids, polymers, metals, and nonmetallic inorganic compounds (silica, graphene, etc.) are being systematically used for healing studies on diverse sicknesses, along with cardiovascular sicknesses, neurodegenerative sicknesses [14,15], most cancers autoimmunity, and so on. These structures cannot best supply specific styles of tablets, along with chemicals, proteins, and nucleic acids, in a managed way however additionally sell the powerful accumulation of medicine on the goal site, thereby enhancing healing efficacy and decreasing poisonous facet effects.

Biomaterials with Inherent Anti-Obesity Activity

Some biomaterials exert the impact of weight reduction on their very own with none drug loading, as indexed in Chitosan, a herbal polysaccharide composed of glucosamine and N-acetyl glucosamine copolymers, has been proven to have anti-weight problems effects and for that reason may be used as a lipid-reducing nutritional supplement. The anti-weight problems impact of chitosan became formerly concept to rise up from its particular fats-binding properties, which intrude with the absorption of nutritional lipids on the intestinal stage. However, latest research advocate that the anti-weight problems feature of chitosan includes a extra complicated endocrine mechanism; that is, it really works through regulating the concentrations of adipocytes, along with serum leptin and c-reactive protein (CRP). As stated above, leptin is a hormone secreted through adipocytes. When frame fats will increase or the frame is in a high-electricity state, the serum leptin stage will increase, and the brain's hypothalamus will acquire a sign to forestall eating.

Biomaterial-Encapsulated Synthetic Drugs for Anti-Obesity Treatment

This phase opinions 4 artificial anti-weight problems pills, namely, orlistat, rosiglitazone, thiopental sodium, and bindarit. These pills exert their anti-weight problems consequences especially via way of means of inhibiting the interest of gastrointestinal lipase, inducing WAT browning, stopping lipid peroxidation, and decreasing triglycerides and glucose stages with inside the body.

Biologic Drugs for Anti-Obesity Treatment

Numerous organic pills, inclusive of peptides, miRNAs, cytokines, etc., have the capabilities of inhibiting the improvement of inflammation, controlling lipid metabolism, and regulating glucose uptake. For example, interleukins IL-four and IL-10 set off an boom in M2 macrophages and a lower with inside the secretion of pro-inflammatory cytokines; the pro-apoptotic peptide KLA disrupts mobile mitochondrial function, ensuing with inside the launch of cytochrome C and the induction of apoptosis. PDBSN, a bioactive peptide, can inhibit adipocyte differentiation, and miRNA pills inclusive of miR33 and miR-130b can alter lipid metabolism. However, those organic pills all face balance and concentrated on issues in vivo [16]. To cope with this

problem, researchers have coupled small-molecule pills to polymers or implemented service substances inclusive of liposomes and polymeric scaffolds to lengthen the half-existence of pills, regulate drug launch profiles, absorption, and distribution, etc. to enhance the drug usage quotes and protection.

Genetically Engineered Drug Delivery

Islet amyloid polypeptide (IAPP) and irisin are capability browning hormones for the remedy of weight problems. IAPP, additionally called pancreatic precipitin, is launched from the pancreas, growing power expenditure. Iridin successfully converts WAT to brown adipose tissue and improves glucose tolerance, triggering a thermo genic program. However, protein-primarily based totally pills have a brief half-existence, require common management, and can even reason dangerous immune responses. Therefore, plasmids containing each IAPP and iridoid gene systems had been developed. Linear polyethylene mine became used as a gene shipping vehicle, that is taken into consideration the gold well known for polymer-primarily based totally gene shipping with low toxicity, smooth modification, low immunogenicity, and lysosomal escape. It became showed that combinatorial gene remedy had a synergistic impact on weight reduction in DIO mice.

CONCLUSIONS

Over the beyond decades, despite the fact that researchers have made first rate efforts, traditional weight problems remedies are nevertheless insufficient to keep metabolic homeostasis and save you existence-threatening complications, so there may be an pressing want for treatments with better efficacy and specificity. The non-stop improvement of drug shipping structures is vital for advances in agent-primarily based totally sickness remedy and numerous sorts of service substances, inclusive of liposomes, micelles, or vesicles, and transdermal microneedles had been developed. Combining anti-weight problems pills with those substances can enhance drug balance, lengthen their half-existence, boom drug enrichment in unique cells or tissues, and decrease damaging consequences. While those biomaterial-engineered focused retailers have done excellent efficacy in mouse fashions of high-fats diets, medical transformation continues to be a challenge. Further complete checks are required to decide whether or not the usage of those substances in people increases protection troubles and whether or not they've excellent efficacy in people and require long-time period management to attain solid weight reduction.

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