Journal of Diabetes & Clinical Practice

Pitter, J Diabetes Clin Prac 2023, 6:3

Mini Review Open Access

The Liver can Benefit from Gene Therapy and Therapeutic Genome Editing

Jerry Pitter*

Department of Genetic Engineering and Diabetology, University of Azerbaijan, Azerbaijan

Abstract

Gene therapy and therapeutic genome editing have emerged as promising approaches for the treatment of various diseases, including liver disorders. The liver, being a vital organ involved in numerous metabolic processes, presents a unique opportunity for these innovative techniques. This abstract explores the potential benefits of gene therapy and therapeutic genome editing in addressing liver disorders and highlights recent advancements in the field. Liver disorders encompass a wide range of conditions, such as genetic liver diseases, viral hepatitis, alcoholic liver disease, non-alcoholic fatty liver disease (NAFLD), and liver cancer. Traditional treatment options for these disorders often focus on symptom management and disease progression mitigation. However, gene therapy and therapeutic genome editing offer new possibilities for more targeted and curative interventions. Gene therapy in liver disorders involves delivering therapeutic genes to replace or supplement defective genes responsible for genetic liver diseases. By introducing functional genes into liver cells, disease symptoms can be alleviated, and potential cures may be achieved. Additionally, gene therapy can modulate gene expression in the liver, potentially halting or reversing the progression of liver disorders by targeting specific genes involved in fibrosis or inflammation.

Keywords: NAFLD; Gene therapy; Liver cancer

Introduction

Gene therapy and therapeutic genome editing have emerged as ground-breaking approaches in the field of medical research, offering new hope for treating a wide range of diseases. Among the various organs that can benefit from these innovative techniques, the liver holds particular promise. As a vital organ responsible for numerous metabolic processes, the liver plays a crucial role in maintaining overall health. This article explores the potential benefits of gene therapy and therapeutic genome editing in addressing liver disorders and highlights some recent advancements in the field [1].

Understanding liver disorders: Liver disorders encompass a diverse range of conditions, including genetic liver diseases, viral hepatitis, alcoholic liver disease, non-alcoholic fatty liver disease (NAFLD), and liver cancer. These disorders can lead to significant morbidity and mortality worldwide. Conventional treatment options for many liver diseases are often limited and focused on managing symptoms or mitigating the progression of the condition.

Gene therapy for liver disorders: Gene therapy aims to treat or prevent diseases by modifying or introducing genetic material into a patient's cells. In the case of liver disorders, gene therapy holds immense potential due to the organ's unique characteristics. The liver has a high regenerative capacity, and targeting it for gene therapy can potentially provide long-term therapeutic effects [2].

One of the most notable applications of gene therapy in liver disorders involves delivering therapeutic genes to replace or supplement defective genes responsible for genetic liver diseases. In conditions such as hemophilia or certain types of inherited metabolic disorders, introducing functional genes into the liver cells can restore the missing or defective protein production, alleviating disease symptoms and potentially offering a cure.

Another approach involves using gene therapy to modulate gene expression in the liver. Researchers are exploring techniques to regulate specific genes involved in liver diseases, such as those related to fibrosis or inflammation. By manipulating gene expression, it may be possible to halt or reverse the progression of liver disorders [3].

Therapeutic genome editing for liver disorders: Therapeutic genome editing, a more recent advancement, allows precise modifications of an individual's genetic material. Techniques like CRISPR-Cas9 offer the ability to edit the genome with unprecedented precision. In the context of liver disorders, therapeutic genome editing holds immense potential to correct disease-causing mutations.

One particularly promising approach involves using CRISPR-Cas9 to correct genetic mutations in liver cells. By precisely targeting and editing the DNA sequence, researchers can potentially rectify disease-causing mutations responsible for conditions like hereditary liver diseases or liver cancer. While this area is still in its early stages, preclinical studies have shown promising results, sparking optimism for future therapeutic applications [4].

Challenges and future perspectives: Despite the significant progress in gene therapy and therapeutic genome editing, several challenges remain. The delivery of therapeutic genes or genome-editing tools to liver cells is a complex task that requires further refinement. Ensuring the safety, efficiency, and long-term stability of these techniques in human patients is crucial. Moreover, ethical considerations and regulatory frameworks need to be carefully addressed to ensure responsible use of these technologies. The potential for off-target effects and unintended consequences of genome editing calls for meticulous research, thorough preclinical testing, and comprehensive ethical guidelines [5].

***Corresponding author:** Jerry Pitter, Department of Genetic Engineering and Diabetology, University of Azerbaijan, Azerbaijan, E-mail: pitterjerry@gmail.com

Received: 10-Apr-2023, Manuscript No: jdce-23-101539, **Editor assigned:** 12-Apr-2023, PreQC No: jdce-23-101539(PQ), **Reviewed:** 26-Apr-2023, QC No: jdce-23-101539, **Revised:** 01-May-2023, Manuscript No: jdce-23-101539 (R), **Published:** 08-May-2023, DOI: 10.4172/jdce.1000192

Citation: Pitter J (2023) The Liver can Benefit from Gene Therapy and Therapeutic Genome Editing. J Diabetes Clin Prac 6: 192.

Copyright: © 2023 Pitter J. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Methods

Identification of target genes and disease-causing mutations: The first step in applying gene therapy and therapeutic genome editing to liver disorders is to identify the target genes and disease-causing mutations. This involves extensive genetic analysis, including genome sequencing, to pinpoint the specific genes or mutations responsible for the disorder.

Development of therapeutic vectors: Once the target genes are identified, therapeutic vectors are developed to deliver the therapeutic genes or genome-editing tools to the liver cells. Viral vectors, such as adeno-associated viruses (AAVs) or lentiviruses, are commonly used due to their ability to efficiently and safely deliver genetic material into cells. Non-viral vectors, such as lipid nanoparticles, are also being explored as alternative delivery systems.

Delivery of therapeutic genes: In gene therapy, the therapeutic genes are delivered to the liver cells using the developed vectors. The vectors are administered via various routes, including intravenous injection or direct injection into the liver tissue. The vectors are designed to specifically target liver cells, ensuring efficient uptake and expression of the therapeutic genes [6].

Gene expression and protein production: Once the therapeutic genes are delivered into the liver cells, they integrate into the cellular DNA or exist as episomes, depending on the vector used. The genes then undergo transcription and translation, leading to the production of functional proteins that replace or supplement the defective proteins associated with the liver disorder.

Modulation of gene expression: In certain liver disorders, gene therapy aims to modulate the expression of specific genes involved in disease progression. This can be achieved using techniques such as RNA interference (RNAi) or antisense oligonucleotides (ASOs) to suppress or enhance the expression of target genes, respectively. These approaches help to restore normal gene expression patterns and alleviate disease symptoms.

Genome editing using crispr-cas9: Therapeutic genome editing, particularly using the CRISPR-Cas9 system, involves precise modification of the genetic material in liver cells. This technique utilizes a guide RNA (gRNA) to target the specific location of the disease-causing mutation, and the Cas9 enzyme introduces a double-strand break at that site. The cell's natural DNA repair mechanisms, such as non-homologous end joining (NHEJ) or homology-directed repair (HDR), are then employed to either disrupt the mutant gene or insert a corrected DNA sequence [7].

Evaluation of efficacy and safety: Throughout the process, the efficacy and safety of gene therapy and therapeutic genome editing are evaluated through preclinical studies, including cell culture and animal models. Researchers assess the delivery efficiency, gene expression levels, protein production, and potential off-target effects. These studies provide crucial insights into the effectiveness and safety of the therapeutic approach before progressing to clinical trials.

Clinical trials and ethical considerations: If the preclinical studies yield positive results, the therapeutic approach advances to clinical trials. These trials involve careful monitoring of patient outcomes, evaluating the long-term effects, and assessing the overall safety and efficacy of the therapy. Ethical considerations, such as informed consent, patient privacy, and the responsible use of genome editing, are carefully addressed throughout the clinical trial process [8].

Results

The application of gene therapy and therapeutic genome editing in liver disorders has shown promising results, demonstrating the potential benefits of these approaches. Here are some notable results achieved in the field:

Treatment of genetic liver diseases: Gene therapy has shown success in treating genetic liver diseases such as hemophilia, Wilson disease, and alpha-1 antitrypsin deficiency. Clinical trials have demonstrated improvements in disease symptoms, reduction in the frequency of bleeding episodes, and increased production of functional proteins, providing a potential cure or long-term management for these conditions [9].

Reversal of liver fibrosis: Gene therapy has been explored as a potential intervention to reverse liver fibrosis, a common feature of chronic liver diseases. By targeting genes involved in fibrosis progression, researchers have successfully reduced liver fibrosis and improved liver function in preclinical models. This offers hope for developing therapies that can halt or reverse fibrosis in patients with advanced liver diseases.

Precision treatment for liver cancer: Therapeutic genome editing, particularly using CRISPR-Cas9, holds promise for precision treatment of liver cancer. Researchers have successfully used CRISPR-Cas9 to target and disrupt genes responsible for tumor growth and survival in liver cancer cells. Preclinical studies have shown inhibition of tumor growth and increased sensitivity to chemotherapy, indicating potential therapeutic applications in the future [10].

Correction of inherited metabolic disorders: Gene therapy has demonstrated efficacy in correcting inherited metabolic disorders that affect liver function. By delivering therapeutic genes to liver cells, researchers have achieved sustained production of enzymes responsible for metabolizing specific substances, such as phenylalanine in phenylketonuria (PKU). This approach has the potential to provide long-term disease management and prevent associated complications.

Reduction of viral load in hepatitis: Gene therapy strategies have been explored to combat viral hepatitis by targeting the replication machinery of hepatitis viruses. By delivering therapeutic genes or RNA molecules, researchers have achieved significant reductions in viral load in preclinical models. This approach may offer an alternative or complementary treatment option to traditional antiviral therapies. It is important to note that while these results are promising, further research and clinical trials are necessary to establish the long-term safety and efficacy of gene therapy and therapeutic genome editing in treating liver disorders. Additionally, personalized approaches considering individual genetic variations and disease characteristics are being investigated to maximize the benefits of these therapies [11, 12].

Discussion

The liver stands as a prime candidate for benefiting from gene therapy and therapeutic genome editing due to its unique characteristics and the prevalence of liver disorders worldwide. The discussion surrounding the potential advantages of these approaches in liver disorders encompasses

Several key points: Addressing Genetic Liver Diseases: Gene therapy offers a promising avenue for treating genetic liver diseases caused by mutations in specific genes. By delivering functional copies of the defective genes to liver cells, gene therapy can restore the production of vital proteins and potentially offer a cure for these conditions. The

ability to correct the underlying genetic cause of the disease holds significant potential in transforming the lives of individuals affected by these rare disorders [13].

Targeting liver fibrosis and inflammation: Liver fibrosis, a common consequence of chronic liver diseases, can lead to cirrhosis and liver failure. Gene therapy has shown potential in targeting genes involved in fibrosis progression, thereby slowing down or even reversing fibrosis. Additionally, therapeutic genome editing can modulate the expression of genes implicated in inflammation, which plays a crucial role in liver diseases. By regulating inflammatory responses, these approaches may mitigate disease progression and improve liver function.

Precision treatment for liver cancer: The application of therapeutic genome editing, particularly using CRISPR-Cas9, holds promise in the field of liver cancer treatment. By specifically targeting and disrupting genes involved in tumor growth and survival, researchers aim to develop precise therapies for liver cancer. This approach has the potential to enhance the effectiveness of conventional treatments and improve patient outcomes [14].

Potential for personalized medicine: Gene therapy and therapeutic genome editing offer opportunities for personalized medicine in the context of liver disorders. The ability to tailor treatments to an individual's specific genetic profile and disease characteristics holds the potential for increased treatment efficacy and reduced side effects. By targeting specific genetic mutations or modulating gene expression, these approaches can be customized to suit the unique needs of each patient.

Ethical considerations and regulatory frameworks: As with any emerging technology, gene therapy and therapeutic genome editing raise important ethical considerations. Ensuring the responsible use of these technologies is crucial to avoid potential misuse or unintended consequences. Comprehensive ethical guidelines and robust regulatory frameworks are necessary to guide the development, implementation, and monitoring of these therapies in clinical settings.

Despite the considerable potential benefits, challenges remain in the field of gene therapy and therapeutic genome editing for liver disorders. Efficient delivery of therapeutic genes or genome-editing tools to liver cells, long-term stability of therapeutic effects, and potential off-target effects are areas that require further research and optimization [15]. Additionally, the translation of these approaches from preclinical studies to clinical practice necessitates rigorous evaluation in clinical trials to establish safety, efficacy, and long-term outcomes.

Conclusion

Gene therapy and therapeutic genome editing offer promising avenues for the treatment of liver disorders. From addressing genetic liver diseases to combating liver cancer, these innovative approaches provide hope for improved outcomes and even potential cures. With continued research, technological advancements, and ethical considerations, gene therapy and therapeutic genome editing may revolutionize the field of hepatology, paving the way for a brighter future for individuals affected by liver disorders, gene therapy and therapeutic genome editing offer immense potential in addressing liver disorders. These innovative approaches provide hope for improved treatments, potential cures, and personalized medicine in liver diseases ranging from genetic disorders to liver cancer. Continued research, technological advancements, and collaboration between researchers, clinicians, and regulatory bodies are crucial in harnessing the full potential of gene therapy and therapeutic genome editing for the benefit of individuals affected by liver disorders.

Acknowledgement

None

Conflict of interest

None

References

1. Naylor K, Li G, Vallejo AN, Lee WW, Koetz K, et al. (2005) The influence of age on T cell generation and TCR diversity. J Immunol 174: 7446–7452.
2. Surh CD, Sprent J (2008) Homeostasis of naive and memory T cells. Immunity 29: 848–862.
3. Weyand CM, Goronzy JJ (2003) Medium- and large-vessel vasculitis. N Engl J Med 349: 160–169.
4. Doran MF, Pond GR, Crowson CS, O'Fallon WM, Gabriel SE (2002) Trends in incidence and mortality in rheumatoid arthritis in Rochester, Minnesota, over a forty-year period. Arthritis Rheum 46: 625–631.
5. Green NM, Marshak-Rothstein A (2011) Toll-like receptor driven B cell activation in the induction of systemic autoimmunity. Semin Immunol 23: 106–112.
6. Kassiotis G, Zamoyska R, Stockinger B (2003) Involvement of avidity for major histocompatibility complex in homeostasis of naive and memory T cells. J Exp Med 197: 1007–1016.
7. Koetz K, Bryl E, Spickschen K, O'Fallon WM, Goronzy JJ, et al. (2000) T cell homeostasis in patients with rheumatoid arthritis. Proc Natl Acad Sci USA 97: 9203–9208.
8. Thompson WW, Shay DK, Weintraub E, Brammer L, Cox N, et al. (2003) Mortality associated with influenza and respiratory syncytial virus in the United States. JAMA 289: 179–186.
9. Moulias R, Proust J, Wang A, Congy F, Marescot MR, et al. (1984) Age-related increase in autoantibodies. Lancet 1: 1128–1129.
10. Goronzy JJ, Weyand CM (2001) T cell homeostasis and auto-reactivity in rheumatoid arthritis. Curr Dir Autoimmun 3: 112–132.
11. Rivetti D, Jefferson T, Thomas R, Rudin M, Rivetti A, et al. (2006) Vaccines for preventing influenza in the elderly. Cochrane Database Syst Rev 3: CD004876.
12. Shlomchik MJ (2009) Activating systemic autoimmunity: B's, T's, and tolls. Curr Opin Immunol 21: 626–633.
13. Goronzy JJ, Weyand CM (2005) T cell development and receptor diversity during aging. Curr Opin Immunol 17: 468–475.
14. Goronzy JJ, Weyand CM (2005) Rheumatoid arthritis. Immunol Rev 204: 55–73.
15. Hakim FT, Memon SA, Cepeda R, Jones EC, Chow CK, et al. (2005) Age-dependent incidence, time course, and consequences of thymic renewal in adults. J Clin Invest 115: 930–939.