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MYOTONIC DYSTROPHY TYPE 1: FROM ORIGIN TO MODERN CONTROL: A COMPREHENSIVE REVIEW

Mr. Haris Riaz Khan[*1], Dr. Sadiq Noor Khan[2], Dr. Saima Siddiqui[3], Dr. Noor Ul Ain[4], Mr. Usman Ayub Awan[5], Mr. Noman Ahmed[6]

*[*1,2]Department of Medical Lab Technology, The University of Haripur*
[3,4]Institute of Biomedical and Genetic Engineering, Islamabad, Pakistan
[5,6]Department of Medical Lab Technology, The University of Haripur

[*1]Harisriazkhan3@gmail.com, [2]snkhan@uoh.edu.pk, [3]Saima_rwp@yahoo.com, [4]Noorulain.sbs@pu.edu.pk, [5]Usman.ayub111@gmail.com, [6]Ahmednomi.116@gmail.com

ABSTRACT

***Background**: Myotonic Dystrophy Type 1 (DM1) (OMIM 160900) is an autosomal dominant, multisystemic disorder characterized by a range of phenotypic manifestations and progressive disease course. It is the most common muscular dystrophy in adults and is known for its variable symptoms and significant impact on quality of life.*

***Objective**: This review aims to provide a comprehensive overview of DM1, including its history, epidemiology, causes, symptoms, pathogenesis, genetic basis, and current diagnostic and therapeutic strategies.*

***Methods**: We conducted a literature review focusing on historical developments, molecular mechanisms, clinical manifestations, and treatment approaches related to DM1. Data were synthesized from a range of academic sources and primary research articles.*

***Results**: DM1 was first described in 1909 and has since been linked to CTG repeat expansions in the DMPK gene. Epidemiological studies show variable frequencies of DM1 across different regions, with higher incidences in Europe compared to Asia. The disorder presents with diverse symptoms including muscular weakness, cardiac abnormalities, respiratory issues, endocrine dysfunctions, and nervous system complications. The underlying pathogenesis involves toxic RNA gain-of-function effects resulting from expanded CTG repeats. While no cure exists, supportive treatments and emerging gene therapies offer hope for managing symptoms and potentially correcting the underlying genetic defects.*

***Conclusions**: DM1 remains a challenging disorder with a complex pathophysiology. Advances in molecular genetics and therapeutic strategies, including gene editing technologies, are paving the way for improved management and potential future treatments.*

***Keywords:** CTG, DM1, DMPK, Expansion of CTG repeats, Myotonic Dystrophy Type 1, Prevalence*

INTRODUCTION

1.1 Myotonic dystrophy type 1

Myotonic Dystrophy Type 1 (DM1) also called Batten disease, Steinert and Gibb disease (OMIM 160900) is an autosomal, multisystemic, rare genetic disorder that has variable phenotypic characteristics and has a slowly

progressive disease course. This disorder is the most frequent muscular syndrome in adults which brings consequences of disabilities and a shortening of life span [1].

DM1 is characterized by a highly variable clinical presentation, which poses significant challenges in patient management and the development of clinical trials. The disease can emerge at any age, from infancy to late adulthood, with a wide range of onset patterns. Symptoms can vary greatly in terms of severity and the specific organ systems affected, often making the course of the disease unpredictable. This variability complicates the process of diagnosis, ongoing care, and treatment, while also presenting difficulties in designing clinical trials to assess potential therapeutic interventions [2].

1.2 Current Challenges:

1. **Diagnosis and Misdiagnosis:** The clinical presentation of DM1 can vary widely and may mimic other neuromuscular disorders, leading to delays in diagnosis or misdiagnosis. Many healthcare providers lack awareness of the disease's broad symptoms, complicating timely identification.
2. **Symptom Management:** DM1 manifests with diverse symptoms, including muscle weakness, myotonia, dysphagia, cardiac arrhythmias, and endocrine dysfunction. Currently, there is no standardized treatment regimen, leading to inconsistent management strategies.
3. **Genetic Counseling and Family Planning:** As a hereditary condition, DM1 raises significant concerns regarding genetic counseling for affected families. The anticipation phenomenon, where symptoms worsen in successive generations, complicates family planning and necessitates clear communication of risks.
4. **Quality of Life and Psychological Impact:** The chronic nature of DM1 can lead to decreased quality of life and increased social isolation. Psychological issues, including anxiety and depression, are prevalent but often inadequately addressed in clinical settings.
5. **Research and Treatment Development:** There is a pressing need for targeted research to understand DM1's pathophysiology better and to develop effective therapies. Current treatments primarily address symptoms rather than modifying disease progression.
6. **Healthcare System Navigation:** Patients with DM1 often struggle to navigate healthcare systems due to the multidisciplinary nature of their care. Coordination among specialists is essential but frequently falls short, resulting in fragmented care.

2. Methodology

This review article was compiled through a comprehensive literature search and synthesis of available data on Myotonic Dystrophy Type 1 (DM1). The methodology employed for this review is outlined as follows:

2.1 Literature Search Strategy

A detailed literature search was conducted to gather relevant information on various aspects of DM1, including its history, epidemiology, pathophysiology, symptoms, diagnostic approaches, and potential treatment strategies. The search included a wide range of databases, such as PubMed, Google Scholar, and Scopus, focusing on articles published between 1909 (the first description of DM1) and the present. Keywords used in the search included "Myotonic Dystrophy Type 1," "DM1," "DMPK gene," "CTG repeats," "genetic mutation," and "gene therapy." Both original research articles and review papers were included.

2.2 Inclusion and Exclusion Criteria

The inclusion criteria for the articles were:

- Peer-reviewed journal articles.
- Articles focusing on DM1, including its genetic basis, epidemiology, clinical manifestations, diagnosis, and treatment.
- Studies and reviews discussing gene therapy and advancements in DM1 treatment.

The exclusion criteria were:

- Non-peer-reviewed articles.

- Studies focusing on other forms of myotonic dystrophy or unrelated muscular dystrophies.
- Articles published in languages other than English unless a reliable translation was available.

2.3 Data Extraction and Synthesis

Data were extracted from the selected articles and categorized into specific themes corresponding to the various aspects of DM1. The themes included:

- History and Evolution of DM1: Analysis of the historical background and discovery milestones of DM1.
- Epidemiology: Summarization of the frequency and distribution of DM1 across different geographical regions.
- Genetic and Molecular Basis: Detailed exploration of the genetic mutation (CTG repeats in the DMPK gene) responsible for DM1 and its pathogenic mechanisms.
- Clinical Manifestations: Compilation of the multisystemic symptoms associated with DM1, including cardiac, respiratory, endocrine, nervous system, and other complications.
- Diagnosis: Overview of the laboratory, electrophysiological, and molecular diagnostic techniques used in DM1 detection.
- Treatment and Management: Examination of current treatment strategies, supportive care, and the potential role of gene therapy in DM1.

2.5 Review and Interpretation

The extracted data were synthesized to provide a comprehensive overview of the current understanding of DM1, from its molecular underpinnings to clinical management. The review also highlighted the gaps in knowledge and areas where further research is necessary, particularly in the development of gene therapy approaches.

2.6 Ethical Considerations

As this review article is based on previously published research, there were no direct ethical concerns. However, the review adheres to ethical standards in research, ensuring that all data and literature are appropriately cited and credited to the original authors.

3. Results and Discussion

3.1 History of Myotonic dystrophy type 1

Myotonic Dystrophy Type 1 is the classical form of Myotonic dystrophy (OMIM 160900) which was first described in the 1909 [3-5].

In 1912, Curschmann discovered a high frequency of familial cataracts and introduced the term multisystemic disorder in 1936. Curschmann discovered the increased occurrence of familial cataracts in 1912 and gave the name multisystemic syndrome in 1936 [6, 7]

In 1992, it was discovered that DM1 was caused by the expansion of CTG repeats in 3' untranslated region of the *DMPK* (*Dystrophia Myotonica Protein Kinase*) gene on chromosome 19 [4, 8-10].

Table 1.1 shows the history of Myotonic Dystrophy Type 1.

Table 1.1: History of Myotonic Dystrophy Type 1

Year	Scientist Name	Information about DM1	References
1909	Hans Guatav Wilhem Steinert	First described	[3-5]
1912	Curschmann	Familial cataract discovery	[6, 7]
1936	Curschmann	Term Multisystemic syndrome	[6, 7]
1992	Aslanidis, Buxton and Harley	Gene location with CTG mutation	[4, 8-10]

3.2 Epidemiology of Myotonic dystrophy type 1

In Asia, the frequency of Myotonic Dystrophy Type 1 is very low, [11], whereas in Europe and New Zealand, its frequency is found to be 10 to 12/100,000 [12], Additionally, in Europe, it has a frequency of 10 to

12/100,000, which is cited by most of the authors [13-17]. DM1 has a higher frequency of 18/100,000 in Croatia, as shown in Table 1.2 [18].

Table 1.2 Epidemiology of Myotonic Dystrophy Type 1

Region/Country	Year of Publication	Prevalence	References
Vastra Gotaland Region (Western Sweden)	2017	17.8/100 000.	[19]
Gothenburg (Western Sweden)	2017	14.1/100 000,	[19]
Taiwan (Asia)	2003	0.46/100,000	[11]
Otago (New Zeeland)	2006	11.6/100,000	[12]
Northern Ireland	1996	1/2900	[13]
Northern England	2009	10.6/100,000	[15]
North East Italy	2001	9.31/100,000	[16]
Istria, Croatia	1997	18.1/100,000	[18]
Central Serbia	2005	3.8/100,000	[20]
Pakistan	2020	Reference prevalence of 1/8000	[21]

3.3 Etiology of Myotonic dystrophy type 1

Myotonic dystrophy type 1 (DM1) is a hereditary condition passed down in an autosomal dominant pattern. It arises due to an expansion of CTG repeats within the 3' untranslated region of the DMPK gene. This mutation leads to the production of abnormal RNA, which accumulates in the cell nucleus as RNA foci. These foci interfere with the function of RNA-binding proteins, disrupting normal cell activities. This disruption contributes to various cellular abnormalities, which are responsible for the wide range of clinical features observed in DM1 [22].

3.4 Symptoms/Complications of Myotonic dystrophy type 1

Slowly progressive distal muscle weakness, myotonia, and atrophy are the key symptoms, neck and face muscles are also involved. Dysphagia, nasal speech, and dysarthria are reported recurrently. The most prominent key symptom of DM1 is the early onset cataract with a frequency of 80 to 90 percent (when a patient is over 50 years of age, although they may appear earlier) [23-25]. Symptoms which are related to the DM1 are described below;

3.4.1 Cardiac manifestations

In DM1, heart abnormalities are the most prominent and cause the deaths in one-third of the affected persons. Conduction abnormalities are seen commonly which is followed by atrioventricular arrhythmias. Among these supraventricular arrhythmias are found in 10 percent of the cases [26-29].

3.4.2 Respiratory manifestations

Weakness of the respiratory muscles, and muscular dysfunction of upper airways are frequently observed leading to respiratory failure in the patients of DM1. These manifestations also bring cough effectiveness and respiratory clearance which results in pneumonia and recurrent lung infections. These involvements of the respiratory system and its frequent complications are key causes of death in patients of DM1 [29].

3.4.3 Endocrine manifestations

Endocrine manifestations of DM1 include glucose intolerance, insulin resistance and type 2 diabetes mellitus along with erectile abnormalities and gonadal dysfunction in men are the most common endocrinological problems [30]. In 60 percent of the patients, dyslipidemia was found [31]. Involvement of pituitary glands, thyroid, adrenal, and parathyroid glands can also be found in DM1 patients [32, 33].

3.4.4 Nervous system complications

Abnormalities of the brain including both structural and functional are recurrent in the patients of DM1. Patients with congenital DM1 have a prominent intellectual disability with visualization defects and neurological impairments. Lethargy and extreme daytime sleepiness are the most common symptoms of the DM1 [34, 35]

Depression, frustration, social denial, and anxiety can also be seen [36].

3.4.5 Other complications

Abdominal pain, constipation, gastrointestinal problems, diarrhea, dysphagia, cholecystitis, and occurrence of gallstones are frequently observed in the patients of DM1, especially with dysfunctions of smooth muscles [37].

Alopecia and involvement of skin are seen frequently in the congenital form of DM1 [38].

The most prominent signs and symptoms of Myotonic Dystrophy Type 1 are shown in Figure 1.

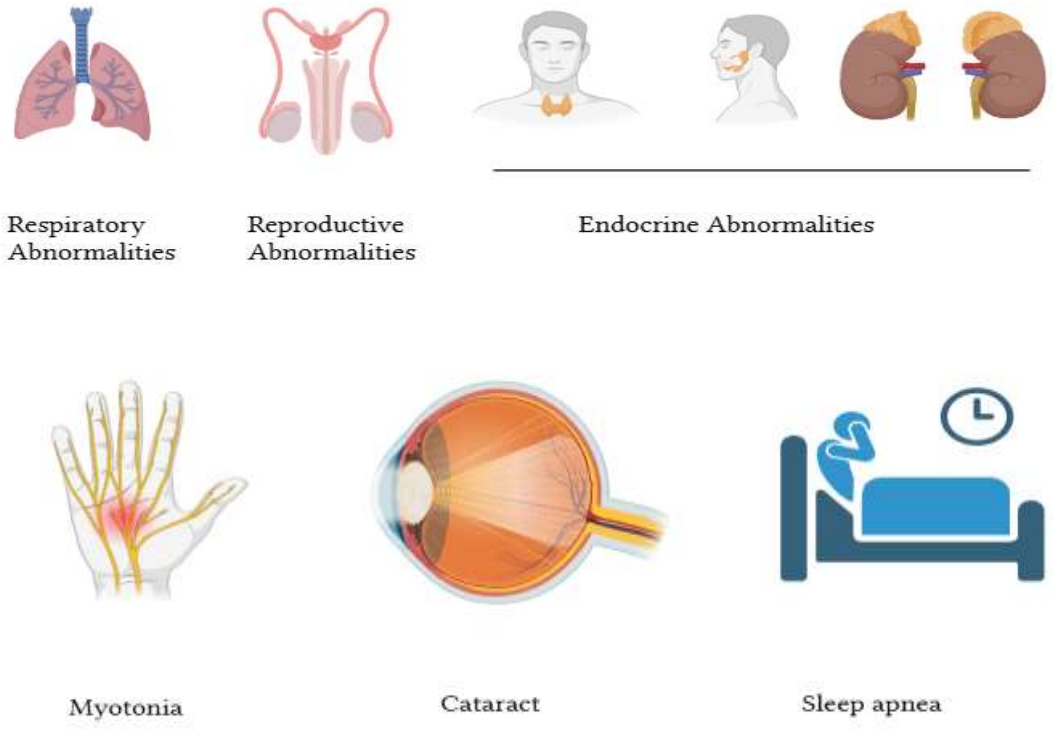

Figure 1: Common signs & symptoms

3.5 Transmission of Myotonic dystrophy type 1

Before 1997, it was believed that females carrying the DM gene were the only way by which DM1 could be transmitted from mother to offspring. It is now evident that the DM1 can also be passed down from the father, despite the fact that this phenomenon does not appear to be prevalent as shown in Figure 2, because of molecular analysis's ability to show the DM1 expansion in presumed carriers [39-42].

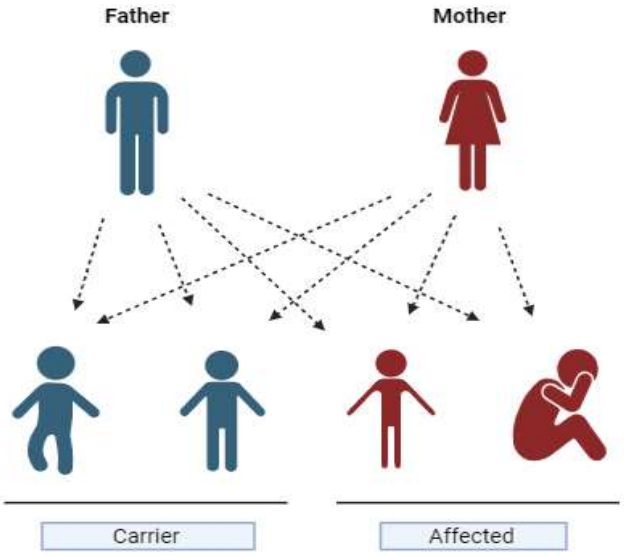

Figure 2: Transmission of DM1

3.6 Pathogenesis of Myotonic dystrophy type 1

Toxicity produced by the expansion of CTG repeats which is present in the 3' UTR of transcripts of the mutant *DMPK* gene is the primary phenomenon of the pathogenesis of DM1. It modifies downstream effectors functions and initiates dysregulations of the gene over modifications in the gene silencing, alternate splicing, transcription, translation, and polyadenylation [43-47].

In DM1, the RBPs which are RNA binding proteins are the most studied families affected by the mutant *DMPK* transcript toxicity which are CUGBP-ETR-3-like and Muscle blind-like (CELF, MBNL) factors, these control the inclusion of alternative exons in various transcripts with respect to the tissues and developmental states indications and alterations in these will lead to the disease progression [48].

The Muscleblind like factors family consists of MBNL1, MBNL2, and MBNL 3 regulators of RNA metabolism, in which the expression levels are closely regulated by developmental stage in each tissue. The MBNL 1 and MBNL 2 are mostly expressed, whereas the MBNL 1 is the paralog which serves as the key function in most of the tissues with the exception of the brain, where the MBNL 2 is mostly detected, and the MBNL 3 level of expression is more limited and is related to the aging, regeneration and muscle cells differentiation inhibition [49-52].

The family of CUGBP-ETR-3-like factors RNA binding proteins consists of six members, which are divided into two groups with respect to their level of expression. Among these CELF 1 and 2 are extremely expressed in many tissues, like, the heart, brain, and skeletal muscles constituting the most and first studied group. Whereas the CELF 6 is present in neurons and can also be seen in testes and kidneys [53, 54].

The alternate splicing is an RNA processing phenomenon that removes the intron between the splicing sites in pre-messenger RNAs to process the mRNAs. Spliceosome mediates this process and is highly regulated by the various motif sequences, in which RBPs recognition takes place, which act as enhancers or repressors of respective splicing sites. This process contributes the significant proteomic variety by allowing single gene to more than one code for messenger RNA and thus have multiple functions to play [55, 56].

The last step in the maturation of RNA is the polyadenylation, and it comprises the cleavage of nascent pre messenger RNA 3' end and poly adenylation tail addition at the site of cleavage, which performs the key function in RNA stability, its efficiency of translation and mRNA localization. And if more than one polyadenylation site is owned by the gene, then the usage difference of those sites are known as the alternative polyadenylation [57, 58].

The alternate splicing and the alternative polyadenylation processes have been described to be altered and perform a key role in the pathogenesis of DM1 [43]

Various pathophysiological mechanisms which are likely to result in DM1 disorder along with some of therapeutic strategies are shown in the Figure 3; [59, 60].

3.7 *Dystrophia Myotonica Protein Kinase (DMPK)* Gene Physiology

The *DMPK* gene encodes threonine/serine protein kinase which is critical for various physiological and developmental functions [61-65].

The key functions of the protein of *DMPK* in the normal tissues are in the heart and skeletal muscles. Regulation of calcium ion homeostasis in myotubes are the main functions of *DMPK* protein, [66], gating sodium ion channel inside the tissues of skeletal muscles [67], myotubes formation from the myoblast cells promotion [68], atrioventricular conduction facilitation and membrane-bound cardiac beta-adrenergic receptors protection are involved are the other activities performed by *DMPK* gene [69, 70].

3.8 Myotonic Dystrophy type 1 and CTG triplets

Individuals with

1. The number of CTG repeats <39 is unaffected and considered normal.
2. The number of CTG repeats between 50 to 99 is said to be pre-mutation and in most patients, cataracts develop.
3. The number of CTG repeats between 100 to 200 have mild or moderate muscular weakness.
4. Patients with a number of CTG repeats between 200 to 1000 are said to be adult onset/juvenile DM1.
5. And the number of CTG repeats between 1000-6000 progresses the congenital or classical form of DM1 [71, 72]. as mentioned in Table 1.3.

Table 1.3: Table showing the number of CTG repeats with DM1 types

No of CTG repeats	Disease cadre
<39	Unaffected/normal
50-99	Pre-mutation
100-200	Mild/Moderate
200-1000	Adult onset/Juvenile
1000-6000	Congenital/Classical

3.9 Types/Forms of DM1

DM1 can be categorized into the four forms which depends upon the time of onset of symptoms;

1. Classical form or congenital form, its symptoms usually shows at birth or first year after birth, and patient represents generalize weakness of muscles, mental retardation and conditions of autism [73].
2. Childhood type, in this type of DM1patient shows the symptoms between the age 1 year to 10 year to show and this form is more severe than the classic form [73].
3. The adult classical type of DM1 occurs between the ages of 10 up to about 40 years and patients exhibit lethargy, cognitive impairment, progressive weakness of muscles, and the myotonia [74]
4. Mild or late-onset type, in this type of DM1, symptoms may occur from the 20 years but usually after the 40 to 50 years age and represents minor symptoms like cataracts or muscular weakness [60, 74, 75]

3.10 Genetics and clinical differences between DM1 and DM2

Both of DM1 and DM2 are autosomal myopathic syndromes and are characterized by myotonia, myopathies, and multisystemic organ contribution [76].

Despite phenotype resemblances, Myotonic dystrophy comprises two hereditarily separate disorders and requires different diagnostic and management policies.

The number of CTG repeats expansion on the *DMPK* gene (MIM *605377) at 3'UTR on chromosome 19q13.3 causes the DM1 or myotonic dystrophy type 1, whereas a (CCTG)n expansion in the first intron of the CNBP gene (MIM *116955) on chromosome 3q21.3 causes myotonic dystrophy type 2 [77, 78].
The number of CTG repeats in DM1 patients ranges from 51 to various thousands with disruptions of CTG array which is reported in approximately 3-5% of patients of DM1 [79-81].
The length of CTG repeats between 38 to 50 are considered as pre-mutation alleles, and it shows increased variability which leads to the higher pathogenic repetition of expansion [76, 82].
In addition to the number of CTG repeats the number of CCTG repeats in the CNBP gene is part of complex phenomena which have polymorphic sections in numbers of (TG) (TCTG) (CCTG) (NCTG) (CCTG) configuration [83].
Healthy individuals contain alleles with less than 30 repeats, while in DM2 these alleles contain 75-11000 CCTG repeats [82]. The Genetics and differentiation of DM1 and DM2 is shown in Figure 5.

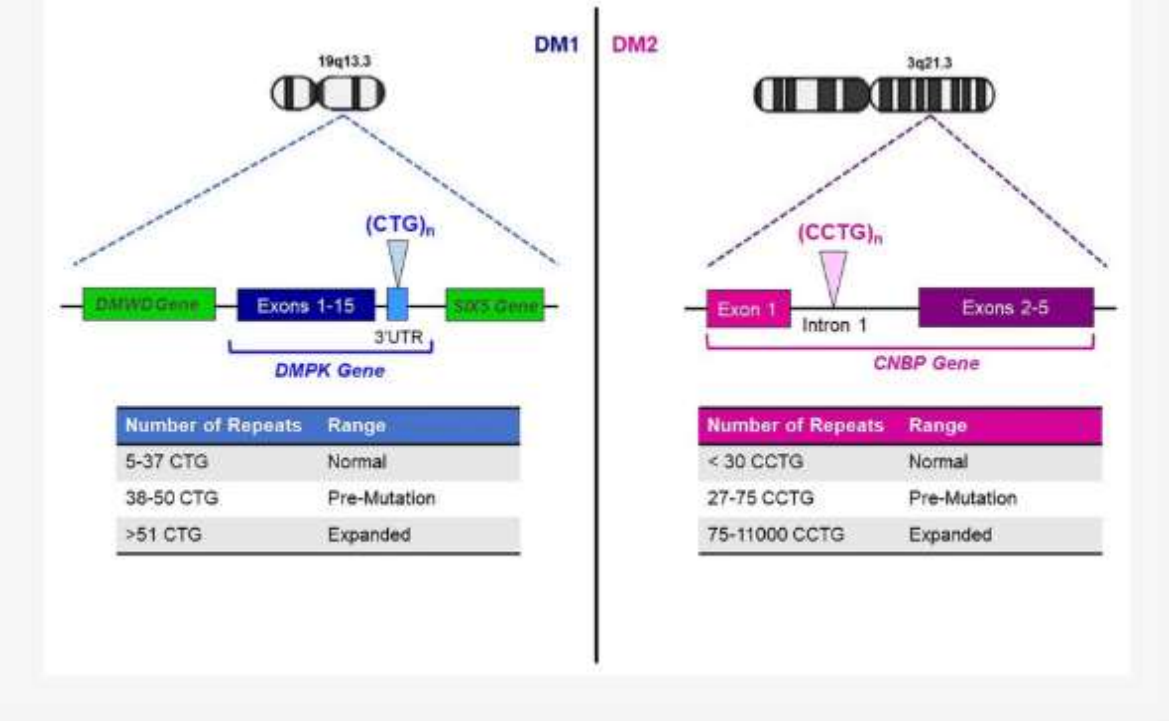

Figure 3: Genetics and differentiation of DM1 and DM2 [77, 78]

3.11 Lab Diagnosis of Myotonic dystrophy type 1

3.11.1 Blood tests

In patients with DM1, the level of creatinine kinase is moderately raised. Common findings are the higher amount of liver enzymes in especially gamma-glutamyl transferase as IgG hypogammaglobulinemia, reasons are unknown [84].

3.11.2 Electrophysiological studies

These studies are used before the development of molecular testing of DM1 and in this, Electromyography is used with the combination of myopathic changes and myotonia for DM1 diagnosis [85].

3.11.3 Muscle histopathology

This type of study is not performed because of the availability of molecular testing of the DM1. However, the histological structures may include the prominent internal nuclei which generally represent as "Row" of the nuclei, ring fibers, variable myofiber size, and myofiber atrophy type 1. In the late stage of DM1 fibrosis may be found and fatty acid replacement may be found [60].

3.11.4 Molecular testing

PCR or the Southern blot are used for the confirmation of DM1 diagnosis and molecular testing is preferred for the DM1 diagnosis. DNA fragments with the repeats of 5 to 125 can be detected by PCR.

Patients of DM1 with two alleles of *DMPK* contain the decrease CTG repeats number and on the gel, two band are appear in patients of DM1 having the increase number of CTG repeats like more than 125 or patients with an equal number of CTG repeats having two *DMPK* alleles then only one band is appeared on the gel. In this situation, a southern blot is used to confirm to diagnosis of DM1. On the southern blot, the expansion of *DMPK* alleles may show as a smear representing different sizes of fragments due to the somatic heterogeneousness.

Presently, a southern blot of white blood cells genomic DNA is the standard method of detection for the alleles of *DMPK* with CTG repeats up to 100 [86].

3.12 Treatment of Myotonic dystrophy type 1

Currently, there is no effective treatment available for DM1 but supportive treatment can be given to patients depending on their symptoms [87].

For patients experiencing symptoms of myotonia, anti-myotonic drugs such as sodium channel blockers may be recommended. Medications like phenytoin, propafenone, mexiletine, procainamide, quinine, flecainide, and carbamazepine have been shown to alleviate the complications associated with myotonia [88].

DM1 patients must be observed for head drop, foot drop, falls, ptosis, dysphagia, dyspnoea, figure flexure weakness, and dysarthria. A regular exercise program for fitness of heart and weight control is advised; though, there is not much evidence to be concluded that exercise can preserve the strength of muscles [89].

Therapeutic strategies for symptoms like muscular weakness include cervical collars, physical therapy, occupational therapy, orthotics, speech or swallow evaluation, and assistive devices such as a wheelchair, or walker are used when needed.

For the patients of DM1 who have weakness of respiratory muscles BiPAP (Bilevel positive airway pressure) is used. Methylphenidate [90] or Modafinil can be used for Ehlers-Danlos disorders [60, 74, 91].

Antiarrhythmic medicines like sodium channel blockers especially Class 1 drugs should be used with care because these drugs may be pro-arrhythmic. For patients who have cardiac conduction abnormalities, cardiac block either second-degree or third-degree, cardiac arrhythmias, or tachycardia a pacemaker and implantable defibrillator should be suggested [26, 92, 93].

Patients with erectile dysfunction, testicular failure or infertility should be referred to specialists. In erectile dysfunction, drugs may be helpful for men. Women with infertility, menstruation issues, and dysmenorrhea should be suggested for obstetrics and gynaecology.

Muscular weakness and myotonia may lead to intestinal dysmotility, dysphagia, and aspiration. Drugs such as erythromycin or metoclopramide can be used to reduce the complications of hypomotility. For constipation, certain dietary modifications like fluids fibres or laxatives should be used.

Cholestyramine can progress to incontinence, diarrhoea, and pain. When this cholestyramine fails, drugs such as norfloxacin can be used to treat the overgrowth of bacteria [91]. The list of medical conditions with their therapeutic strategies are given in Table 1.4.

Table 1.4: Conditions with therapeutic strategies

Conditions	Therapeutic strategies	References
Myotonia	Phenytoin, propafenone, mexiletine, procainamide, quinine, flecainide and carbamazepine	[88]
Head drop, foot drop, falls, ptosis, dysphagia, dyspnoea, figure flexure weakness and dysarthria	Regular exercise program for the fitness of heart and weight control	[89]

Muscular weakness	Cervical collars, physical therapy, occupational therapy, orthotics, speech or swallow evaluation, and assistive devices such as wheelchairs, walkers	[60, 74, 91]
Weakness of respiratory muscles	BiPAP (Bilevel positive airway pressure)	[60, 74, 91]
Ehlers-Danlos disorders	Methylphenidate, Modafinil	[60, 74, 91]
Cardiac conduction abnormalities, cardiac block either second-degree or third-degree, cardiac arrhythmias, or tachycardia	Sodium channel blockers especially Class 1 drugs, pacemakers, and implantable defibrillators	[26, 92, 93]
Erectile dysfunction, testicular failure, or infertility	Refer to the specialists	[91]
Intestinal dysmotility, dysphagia, and aspiration	Erythromycin or metoclopramide	[91]
Incontinence, diarrhoea, and pain	Norfloxacin	[91]

3.13 Future prospective of DM1 therapeutics

CRISPR (clustered regularly interspaced short palindromic repeats) technology has advanced into a versatile tool for both editing and regulating gene expression in a sequence-specific manner. In the context of DM1 syndrome models, it has been specifically adapted to address the underlying genetic abnormalities. This includes targeting and removing expanded DNA sequences, inhibiting their transcription to prevent the production of harmful RNA, and facilitating the degradation of toxic RNA molecules. These tailored modifications aim to directly treat the root cause of DM1 by addressing the genetic and molecular disruptions associated with the condition [94, 95].

4. Conclusion

Myotonic Dystrophy Type 1 (DM1) is a complex, multisystemic disorder that remains one of the most prevalent forms of adult-onset muscular dystrophy. The disease is caused by an expansion of CTG repeats in the DMPK gene, leading to widespread cellular dysfunction through a toxic RNA gain-of-function mechanism. This molecular pathology underpins the diverse and often severe clinical manifestations observed in DM1, ranging from muscle weakness and myotonia to cardiac, respiratory, endocrine, and nervous system complications. The multisystemic nature of DM1 presents significant challenges in management, necessitating a multidisciplinary approach to care that addresses the wide array of symptoms and complications. Geographical variability in the prevalence of DM1 suggests the influence of genetic and environmental factors, with certain populations exhibiting higher rates of the disease. The differentiation between DM1 and DM2, though challenging due to overlapping clinical features, is critical for accurate diagnosis and appropriate management. Advances in molecular diagnostics, particularly the use of PCR and Southern blotting, have significantly improved the accuracy and speed of DM1 diagnosis, reducing the reliance on more invasive procedures like muscle biopsy.

Despite significant advances in understanding the molecular and clinical aspects of DM1, treatment remains largely symptomatic, with no current cure available. Management strategies focus on alleviating symptoms and preventing complications, particularly in the cardiac and respiratory systems, which are the leading causes of morbidity and mortality in DM1 patients. The development of gene therapies, including CRISPR-based approaches, offers promising avenues for future treatment by potentially targeting the underlying genetic cause of the disease. These emerging therapies hold the potential to not only alleviate symptoms but also to modify the disease course, offering hope for patients and their families.

In conclusion, while significant progress has been made in understanding and managing DM1, ongoing research is crucial to unravel the full complexity of the disease and to develop effective therapies. A continued focus on the molecular mechanisms of DM1, combined with advances in genetic therapies, is likely to pave the way for more targeted and effective treatments, ultimately improving outcomes and quality of life for those affected by this debilitating condition.

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Author's Contribution

Conceptualize Study, Study Design, Manuscript Writing
Supervision Support, Provide Critical Review
Supervision support, Critical reviews
Provide critical Review, Methodology, and Data Analysis, manuscript proofreading.
Data Extraction, Manuscript Diagrams
Assist in manuscript writeup, data extraction.

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