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Research/Technical Note

Possible Therapeutic Approach Against Covid-19 by Application of Magnetic Field

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Abstract: A new pandemic named as COVID-2019 (coronavirus disease 2019) has stunned the world. The reason behind this type of pandemic is severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) which is similar to SARS CoV's epidemiology, genomics, and pathogens. This novel coronavirus (SARS-CoV-2) is causing the mainly pneumonia-associated respiratory syndrome, result in the death of human being which is increasing rapidly day by day. The current efforts of the scientist (both physical and biological) in the world is to invent specific antiviral drugs and physical therapeutic against COVID-19. Hence we have tried to discuss in this note how physical therapy may develope against COVID-19. To neutralize +ssRNA, M (membrane)-protein and spike protein-containing into SARS-CoV-2 magnetic field can play a vital role in the presence of nontoxic magnetic nanoparticles. To apply a magnetic field into the SARS-CoV-2, magnetic trap instrument called magnetic tweezers may be used where nontoxic magnetic nanoparticles act as a magnetic bead which alters the orientation of +ssRNA. At the same time, magnetic nanoparticles interacts with M-protein, result in fragmentation of spike protein. We expect that this therapy will be a more effective challenge to control the current pandemic and the possible re-emergence of the SARS-CoV-2 virus in the future.

Keywords: COVID-19, Magnetic Nanoparticle, Magnetic Tweezers

1. Introduction

Coronaviruses are the largest group of viruses belonging to the Nidoviralesorder, which includes Coronaviridae, Arteriviridae, Mesoniviridae, and Roniviridaefamilies. This type of virus includes four genera, such as alpha, beta, gamma, and delta coronaviruses [1]. Among all the genera of the virus, beta coronavirus is single-stranded, positive-sense RNA similar to the mRNA virus with a genome of approximately 30 kD [2]. From December 2019 new beta (+ssRNA) coronavirus named nCoV-19 or SARS-CoV -2 has become one of the major threats to public health systems worldwide. This type of virus is responsible for lethal infections related to the human respiratory system, such as severe acute respiratory syndrome (SARS) and the Middle East respiratory syndrome (MERS). They also infect the gastrointestinal, hepatic and central nervous system of humans, other mammals and birds. As a result, they cause acute respiratory distress and acute lung injury syndrome [3]. Many proteins from beta coronavirus play a vital role to infect a variety of human and animal host cells, which carry out their infection and replication. In this case, it is necessary to know the definition of these proteins in terms of this mechanism. And also known the antiviral effect. In this case, the macro domain is known to be a conserved region of nsp3 present in different viral species including CoVs. plays a major role in the virulence of CoVs since they can infect through protein-protein interactions related to the host immune system [4]. Both the biological and physical scientists in the universe have already taken major steps to prevent entry, destroy and infection of the

SARS-COV-2 virus. As part of them, we have taken theoretical research on the role of nanotechnology and magnetism in the antiviral activity of the SARS-COV-2 virus. At present nanotechnology has become a key point of research in the modern technological view due to its useful application for a human being. Because nanomaterials can affect and govern the fate of the encapsulated drug [5]. Currently, an enormous number of inorganic and polymeric nanoparticles are there in the universe for the treatment of infected cells of the human body by viruses and bacteria. Nontoxic nanoparticles such as carbon nanotubes (CNTs), carbon black nanoparticles, and polystyrene nanoparticles, titanium dioxide nanoparticles, silicon dioxide nanoparticles, aluminum ox hydroxide nanoparticles, some intermetallic nanoparticles, and some pure metallic nanoparticles are more effective to destroy virus [6]. Also, the magnetic field and force play an important role to fight against DNA and RNA viruses. At present, to prevent the hazardous virus-like +ssRNA virus a new class of antiviral drugs has developed by a new type of research with designing replication machinery to pause and backtrack. This research has made possible by a high throughout magnetic force-based experimental technique called "magnetic tweezers," which could speed the development and approval of related antiviral drugs [7]. Magnetic tweezers (MT) can probe the mechanical properties very sensitively and detect the changes in a nucleic acid state like the +ssRNA virus [8]. In this report, we have discussed some reviews of the genome structure of a novel coronavirus named SARS-CoV-2. And also discussed theoretically how the magnetic field and magnetic nanoparticles affect the +ssRNA protein, membrane protein which acts as an antiviral.

2. Materials and Methods

2.1. Genome Structure of SARS-CoV-2

The SARS-CoV-2 contains β-CoV B coronavirus, which is an enveloped non-segmented positive-sense RNA genome of ~29.9 kb. [9]. While SARS-CoV and MERS-CoV have positive-sense RNA genomes of 27.9 kb and 30.1 kb, respectively [10]. This type of RNA genome contains a 5′ cap structure along with a 3′ poly (A) tail, allowing it to act as an mRNA for translation of the replicase polyproteins. The genomic RNA is 50 capped and 30 polyadenylated and is infectious [11]. The virions of coronavirus are spherical having a diameter of about 125 nm [12-13]. Approximately 70% of viral RNA encodes 16 non-structural proteins (NSP) and the rest part of virus genome encodes four essential structural proteins, including spike (S) glycoprotein, small envelope (E) protein, matrix (M) protein, and nucleocapsid (N) protein [14]. Among all the nsp RNA of SARS-CoV-2 encode nsp1 [15]. nsp1s from human SARS-CoV significantly reduce the gene expression in HEK 293 cells [16-18]. SARS-CoV nsp1 enhances the degradation of host mRNA which suppresses host gene expression in several lines [19, 20]. From the point of view of the mRNA virus, it is indicated that SARS-CoV nsp1 also suppresses the expression of the CoV genes [19]. But recent research indicates that CoV mRNAs protects the viral RNA from degradation [21, 22]. Also, membrane protein known as E1membrane glycoprotein or matrix protein is one of the parts of SARS-CoV together with S (spike) protein and E (envelope) protein [23]. After the analysis of the genome sequence of SARS-CoV-2, it is found that approximately 96.2% genome is similar to a bat CoV RaTG13, whereas it shares 79.5% identity to SARS-CoV [15]. According to Tang et al. [24], 103 SARS-CoV-2 genomes have been found which is aligned in sequence and identified the genetic variants. There are two types of SARS-CoV-2 such as L type (~ 70%) and S type (~ 30%). The strains in L type are more aggressive and contagious derived from S type [15]. Based on the genomic analysis it is clear that SARS-CoV-2 could use angiotensin-converting enzyme 2 (ACE2), as similar to SARS-CoV [25], to infect humans.

2.2. Magnetic Tweezers

Magnetic tweezers (MT) are magnetic trap instruments that have been used for studying rheological mechanical properties of single molecules tethered molecules like DNA and RNA [26]. These type instruments are versatile single molecular techniques [27-29] that are capable by applying both force and torque. A single molecule is tethered to a surface at one end and attached to a magnetic bead at the other; the bead is manipulated via external permanent magnets and/or electromagnets. Magnetic tweezers have been widely used to study mechanical and elastic properties of nucleic acids, [29-33] DNA dynamics, [34] DNA/protein interactions, [35-38]torsional properties of DNA, [39-41], DNA/protein complexes and RNA/protein interaction [42, 43]. Also MT may use to interact between +ssRNA like m RNA and spike protein of beta-type SARS-CoV-2 in the presence of PEG and PEI coated magnetic NPs. When the external magnetic field is applied on a magnetic NPs close to SARS-CoV-2 experiences a force proportional to the gradient of the square of the magnetic field. Because magnetic NPs are able to create a mechanical force or torque when interacting with magnetic fields [44]. This magnetic field is generated by sharp electromagnetic tips [45] or small permanent magnets [46] which results in a very steep field gradient and high forces gained with relatively small magnetic field strengths. When permanent magnets or electromagnets are used to control both force and torque, the changes in the field strength and field gradient are intrinsically coupled [47].

3. Discussion

3.1. The Magnetic Field Effect in SARS-CoV-2

The main molecular constituents of the SARS-CoV-2 are membrane protein (M-protein) and +ssRNA. M-protein and

+ssRNA have directionally dependent physical properties, which make their molecules anisotropic in nature [48]. The secondary structures of their two most common protein are alpha-helix and beta-related sheets. The axial alignment of peptide bonds and beta-related sheet produces substantial anisotropy in them [49]. When a magnetic field is applied to the SARS-CoV-2 virus by the magnetic tweezer (MT), the dielectric moment of M proteins may interact with this magnetic field [50]. As a result, membrane voltage may be induced by the electrostatic contributions of the bending energy of charged membranes proteins [51]. The magnetic gradient force across the SARS-CoV-2 virus acts on charged M-proteins and my oppose ions movement through the membranes [50, 52]. This magnetic gradient force is given by the formula [53].

$$\vec{F} = p\frac{d\vec{B}}{dl}$$

where p is the magnetic dipole moment of the ion, B is the magnetic induction, and the first derivative, which is taken with respect to direction l, parallel to the magnetic dipole moment of an ion, $l//p$. From this equation, it is observed that the magnetic dipole moment, produced in M-protein has been created by the contribution of the magnetic term. The direct effect of the application of the gradient magnetic field across the SARS-CoV-2 can manifest itself through the change in the orientation of RNA and achieve membrane potential. The mechanical stress in the M-protein can directly be influenced because membrane potential is changed through agitation of the membrane ion created by magnetic NPs [54, 55]. The magnetic field applied from MT may, therefore, affect the separation of spike protein from the SARS-CoV-2 virus that changes the membrane potential, which plays a key role in the interaction between +ssRNA and RBD of the spike protein and thus may inhibit virus mutation in the human body, in particular in the lung.

3.2. Magnetic Nanoparticles as Antiviral

A SARS-CoV-2 virus with nano-size may be destructed by non-toxic magnetic nanoparticles induced by magnetic field strength without saturation magnetization. This shows weak orientation and the measurements are within the range of validity of the classical Cotton-Mouton (CM) effect (the magnetic analog of the Kerr electro-optic effect). Magnetic nanoparticles (NPs) mainly include metal NPs, metal oxide NPs, and metal alloy NPs. The common magnetic NPs are iron, cobalt, and nickel. Metal oxide NPs mainly include iron oxides, various ferrites, metal alloy NPs, and so on. Magnetic nanoparticles synthesized by ball milling technique [56] show high magnetic properties and a higher relaxation rate, which contributes to their application for magnetic resonance imaging (MRI) [57]. Magnetic NPs show interesting properties such as non-virulence and non-immunogenicity and possess surface effects. In detail, they have a great specific surface area, which may interact with +ssRNA protein, result in a fragment of RNA. After supplying in the presence of a magnetic field the magnetic NPs coated by active material with hydroxyl and carboxyl are subject to being absorbed with body proteins of the lung. To stabilize the nanostructure and improve the surface functionalization of nanoparticles it needs to be surface modified by polyethylene glycol (PEG), polyethyleneimine (PEI), folic acid (FA) [58]. Surface modification can enhance the water solubility, biocompatibility, and stability of NPs; they thus can be served MRI, and operated by Magnetic Tweezers (MT) [59]. Magnetic NPs coated by water-soluble PEG and carboxylated polyethylene mine (PEI-COOH) lead to good application in MRI, MT treatment or other medical diagnoses and treatments [60, 61]. PEG-modified ferrite NPs can enter into lung cells by inhaling through phagocytosis, which may interact with the receptor-binding domain (RBD) of spike protein remaining into the SARS-CoV-2 virus [62]. PEI is a cationic polymer, which can apply to gene fragmentation and gene transfection. When the magnetic field is applied into PEI-modified magnetic NPs have remarkably turned the +ssRNA because of interaction between PEI coated magnetic NPs and protein like membrane protein [63, 64]. When Magnetic field is applied by magnetic tweezers a strong mechanical force is induced which may control the cell and turn the +ssRNA whereas M-protein interacts with PEI coated magnetic NPs. When PEI coated magnetic NPs are supplied to the lung in the presence of a magnetic field then magnetic flux is induced around the M-proteins which affect the virus without changing the other necessary protein [53].

4. Conclusion

From our analysis, it is worth noted that, the pathogen of COVID-19 is SARS-CoV-2 which is closest to RaTG13 like SARS-CoV. Since there is no effective therapeutics or vaccines of COVID-19 we have tried to discuss theoretically that the possibility of the magnetic field effect to neutralize SARS-CoV-2 using magnetic tweezers in the presence of nontoxic magnetic NPs. Our analysis will motivate both the physical and biological scientists across the globe to develop physical therapeutic instruments that may use for the treatment of COVID-2019. We expected that this type of treatment will be developed very soon as an alternative option, which will protect the world from the rapidly increasing death of humans. Thus reduce the death toll of human lives in the world and help the world to regain a normal pace.

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