THE TOTTENHAM JOURNAL OF SCIENCE

A carbon neutral future? Will technology allow us to achieve that?

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A carbon neutral future? Will technology allow us to achieve this?

Since the industrial revolution, humans have released abundant amounts of carbon dioxide into the atmosphere. According to the World Meteorological Organisation, this has been around 375 million tonnes of carbon dioxide. Undoubtedly, this has caused global warming which has created adverse effects on our planet. Since 1880 the global temperature has risen from 0.6˚C to 14.4˚C as of 2015. This rate of warming has been 50 times the rate of warming during the previous 21000 years(Fox 2020). Many global leaders across the globe have issued this as a crisis and one that has to be resolved or mitigated as soon as possible. This article will discuss if using technology is more efficient than expanding forests in reducing carbon dioxide emissions in the atmosphere.

Carbon Dioxide As A Greenhouse Gas

Greenhouses gases naturally occur in the Earth's atmosphere, they absorb the sunlight and gradually radiate heat (Lindsey 2020). They maintain a stable temperature for life to thrive on earth, and without these essential gases, Earth would be too cold for any biological processes to occur. However, with an abundance of these gases, the balance of the atmosphere is disturbed and induces a warming effect. This warming effect has been linked to the recent increase in tropical storms and the melting of the polar ice caps which caused the sea levels in certain areas to rise. Carbon dioxide is one of these greenhouse gases, and maintenance of this gas may allow humans to mitigate the effects of global warming.

Planting Forests

According to scientists, planting billions of trees across the world is one of the easiest and cheapest ways to remove and store carbon dioxide from the atmosphere. Trees, by a process called photosynthesis, use carbon dioxide from the atmosphere to form a glucose molecule, which provides them with the energy for growth. This means that forests encourage the uptake of carbon and are very good at storing it. This is because almost half of the tree's dry mass is carbon.

Although planting trees is very easy and cheap many challenges come with it. Forest expansion in one area could affect other areas of forest or the agriculture that grows with it. For example, restoring farmland in many areas may mean that agricultural farms would be destroyed. This would therefore reduce the supply of food and necessitate the conversion of other forests into farmland. This approach could be seen as counterproductive and only allows the cycle of deforestation to continue. Economic challenges are also present as the reduction in some farmland or, for example, timber plantations may cause some people to lose their jobs and in turn, the industry is also affected.

Another challenge with countries expanding forests is that they use monoculture plantations. This means that a single species of trees are planted over thousands of hectares. Although the number of trees has increased, after around 10 years, they are harvested which releases a lot of the carbon stored

back into the atmosphere. Again this is counterproductive.

BECCS

Bio-energy with carbon capture and storage, otherwise known as carbon capture and storage is a process of using biomass for energy in the transport or industrial power sectors(Mulligan 2020). This revolutionary new technology uses fast-growing trees and soil and grass as its biomass. This is then incinerated to produce energy and instead of the emissions escaping it is captured and stored either underground or mixed in long-lived products for example concrete.

According to the intergovernmental panel on climate change, IPCC, BECCS requires 25-46% of arable cropland. This means that trees in forests that already exist would have to be removed to make space for fast-growing trees. This would not only decrease the biodiversity in the area but may cause the soil in the area to become weak and encourage soil infertility.

Dr. Anne Harper from Exeter university stated that more carbon was stored by forests than by employing BECCS. This highlights that BECCS, as a relatively new technology, may need to be adapted further to become as efficient as possible in storing carbon emissions.

Both natural and technological methods of capturing carbon dioxide are important and either one cannot alone deliver the scale of negative emission required, without serious challenges. Nonetheless, the technical advancements are relatively new and therefore it is unknown what may occur in the future if countries rely on them exceedingly. Although the expansion of forests may take relatively longer to implement it is cheaper and also an easier approach. As Hollande said we must ‘protect and hand on the planet to the next generation’.

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THE TOTTENHAM JOURNAL OF SCIENCE

Boiling and Unboiling an Egg

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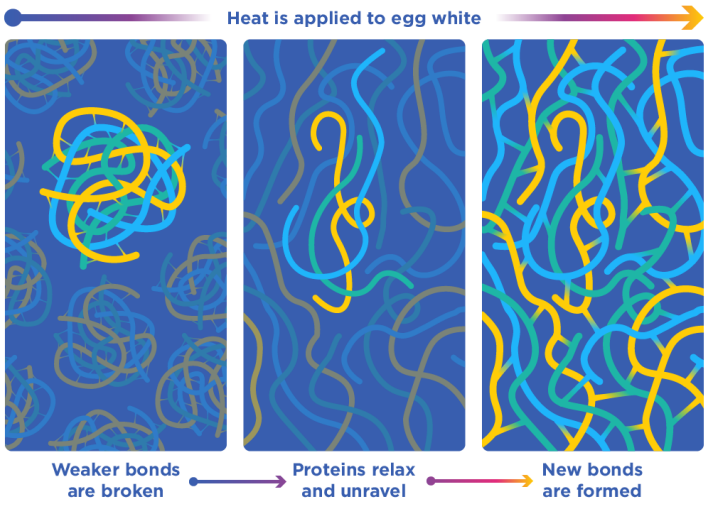
Boiling and Unboiling an Egg

Boiling

Have you ever thought about why an egg gets harder when you turn up the heat? I mean it's called a “hard-boiled” egg so why isn’t it a gas wafting around in the air? What is so special about an egg…
All eggs are mainly made up of 2 parts, the white and the yolk. If we again delve deeper, the egg whites have 3.6g of protein and 2.7g in the yolk, summing up to 6.3g of protein in one egg. That’s a lot of protein for one egg.

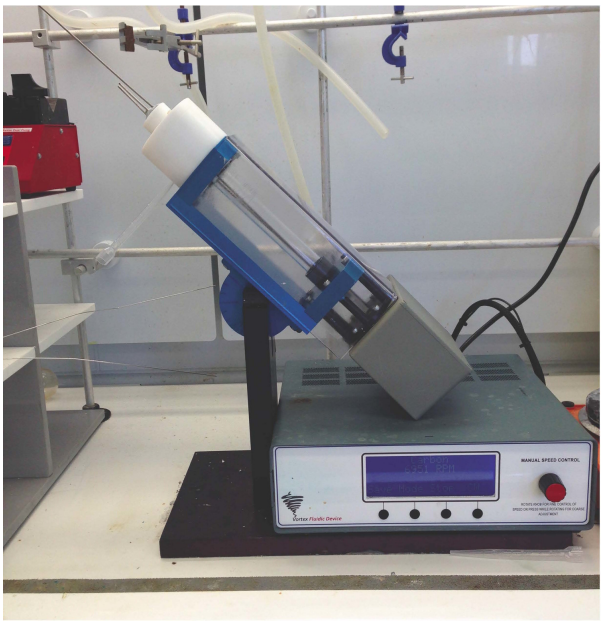
But why does it get harder?
Denaturation. All proteins are made of amino acids and within the egg, these amino acids are coiled and folded into specific shapes held together by weak chemical bonds. Adding heat will only break their bonds causing the acids to shimmy free of each other.
Pretty liberating for them, I know.
But the more thermal energy being applied, these chains will actually create new stronger bonds and eventually clump together being so intertwined, that we then get our solid, hard-boiled egg. What an entanglement.



So what if we wanted to unboil the boiled egg.
Just for fun.

Unboiling

Now you’d think it would be simple to just reverse the process, we apply heat so now we freeze it? Well you go try and put a hard-boiled egg in the freezer, tell me your results.



Spoiler alert…I tried, it doesn't work.

No, instead scientists, Weiss and Ratson used mechanical energy to reverse this instead of thermal energy in their experiment.
Ratson had earlier created a machine called the vortex fluid device, which has a glass tube connected to a motor. Sounds complicated, it isn't. Essentially it's a smaller, faster washing machine.

1. **Preparation**

They first dissolved the boiled egg whites into a solution containing water and urea. Urea would act as a lubricant, so the tangled chains can slide past each other easier. They then pour this solution into the glass tube and the magic begins.

2. **The Magic**

This motor spins the glass tube at a ridiculously high speed, using shear forces to make the proteins pull away from each other and stretch and fold and stretch and fold. Eventually, after a few minutes the amino acids will revert back to its original native form, and you will see the same egg white from before you boiled the egg.

Of course, this experiment wasn't done just so Gordan Ramsay could fix his breakfast.
Lots of pharmacists are producing drugs and medicine that take up lots of funding, energy and time due to it becoming tangled and then having to untangle and refold these proteins.
Weiss and Ratson's simple process takes minutes compared to the days the industry used to take. They didn't win a Nobel Prize for nothing.

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Something In The Air

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Something In The Air

This article targets the issue of the delays in accepting that COVID-19 can be transmitted through the air. It is an interview with an aerosols expert Professor Lidia Morawska. The article starts off talking about Morawska's efforts to persuade the WHO to implement regulations to prevent the transmissions of coronavirus through the air.

Morawska goes on to explain the reason why so little research was done about aerosol transmission of diseases and tells us about the incomplete research and lack of research funding, due to the fact that people were unwilling to believe aerosol transmission is possible. I believe that this was a good way to introduce the problem to the audience as it gives some background to the problem, and that aerosol transmission is not a new idea being tried out but an idea that has been researched before. However, I believe Morawska, or the interviewer could have given some information to the audience about aerosol transmission, as many people reading it may not be up to date on these scientific ideas.

The interviewee then explains why aerosol transmission was thought to be untrue. She explains that it is due to a medical dogma that was developed in the 1930-40s, which was that if you stood an arm's length away from an infected person you were not going to catch the disease. This misunderstanding was created because scientists were only able to detect and study larger droplets: they did not have the means to investigate smaller droplets. However, this medical dogma still persists as was shown when the WHO director general tweeted "the virus is not airborne". I believe this was a very good way to describe exactly why the aerosol transmission idea kept getting shut down and the use of the link between an old baseless medical dogma and modern scientific experts was also very good at making the audience realise the shortcomings of the medical community in understanding this idea.

Next, the Professor goes on to talk about the little research that has taken place that suggests aerosol transmission of diseases is possible. She explains that another reason why there is not much modern research on this is because it is hard to do the research during the pandemic. There are many logistical hurdles that arise due to the lockdown, for example, you can not rigorously assess all parameters in the research and can not get volunteers with COVID and ethical clearance. The few research studies done have shown convincing evidence that the smallest size microdroplet has the highest viral load, and is therefore an indication that aerosol transmission is why this disease is so transmissible.

The interviewer goes on to ask Morawska a controversial question; “Do you think that public health organisations and governments were reluctant to take airborne transmission seriously because it is so much more worrying and difficult to control?”. Morawska answers, explaining that the reason why masks were not enforced by the government earlier was because a) experts advised the government that it is not a significant mode of transmission and b) that masks were not available at that time. This does not justify their reluctance in introducing mask guidelines because if there is no demand for masks in the market, the market will follow and not supply masks. I felt that this was powerful for the professor to come out and spread this information as it shows how the organisations were misguided by experts and reluctant to generate demand for masks in the market. This idea that the market will not supply unless there is demand was evident when seeing the spike in mask sales following the government imposing regulations on mask-wearing.

Overall, I thought this article was very informative and just what people needed to know as it answers many of the questions myself and other people have had regarding the pandemic - especially the confusion that the public health organisations and governments had spread amongst the public about face masks. Despite the fact that this was not a traditional article with many different opinions, Professor Lidia Morawska had explained the reasons very clearly and backed them up with facts. Her explanations were very thorough but understandable to any non-expert.

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Alice in Wonderland - Story or Syndrome?

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Abstract

A description of Alice in Wonderland syndrome (AiWS) and how the syndrome got its bizarre name. The Alice in Wonderland syndrome is when the patient has hallucinations of distorted parts of their body in space and time. In this article, it is described how the syndrome was first discovered and how it exactly reduces the patient's ability to perceive certain body parts properly. Symptoms and case studies of the AiWS have also been mentioned to give a greater understanding of the syndrome.

Alice in Wonderland (AiWS) is a neurological syndrome of distorted space, time, and body image. A patient with Alice in Wonderland syndrome may believe that their entire body or parts of it has been altered in shape and size. This syndrome is usually associated with visual hallucinations.

It was discovered by Dr. John Todd, who had first noticed that many of the pediatric patients that visited the psychiatric department experienced distortion in the size of objects or body parts. This distortion is known as metamorphosis. The patients had typically come in presenting with severe migraines. Dr. Todd observed the children over a period of time and realised that there was a link between the migraines and other symptoms that the children had. He had then discovered that they had a rare migrant variant, thus he named it, 'Alice in Wonderland syndrome'.

The name was influenced by the well-known novel written by Lewis Carroll - Alice in Wonderland, where a girl enters a dystopia world and goes through a series of metamorphic changes such as being larger and smaller than she was before entering the wonderland. The part where her size changes, links the novel to the syndrome, as this is one of the main symptoms due to migraines. It is important to note that Alice in Wonderland Syndrome is a symptom of migraines. It was later discovered that Carroll, the writer of Alice in Wonderland, had experienced severe migraines which had inspired the novella.

Alice in Wonderland syndrome is commonly experienced during childhood and tends to disappear during teenage years. It is said to have been caused by abnormal amounts of electrical activity in the brain resulting in abnormal blood flow in the parts of the brain that processes visual perception and texture. This has damaging effects on that part of the brain, which links to the main symptom where the perception of size is distorted. Reports suggest that the symptoms of mononucleosis (an infectious disease also known as glandular fever), commonly occurs as AIWS in childhood but is said to disappear around the teenage years.

Due to the variety of symptoms, these can vary between individuals, such as depersonalisation(feeling disconnected from one's body and not understanding their thoughts), lacking consciousness, changes in shape, or distance of objects. In children, patients often feel as if they are not in the present or physically there. Depersonalisation disorder is often a symptom of a migraine but also epileptic auras(a warning that some

patients feel before they suffer from a stroke), and is sometimes experienced by some patients in response to stress, tiredness, or drug use.

The parietal lobe is a section of the brain which is responsible for integrating sensory information. It determines the perception of our body parts in space. It has thus been affected in the Alice in Wonderland theory as distorted perception is the main factor that affects patients. The electrical stimulation of the posterior parietal cortex has been shown to produce disturbances in body image, such as hallucinations of limbs growing or disappearing.

A case study of a 12-year-old with Alice in wonderland syndrome, who showed the increase in the activation of the parietal lobe combined with the reduction in the visual cortex areas during metamorphopsia. This confirms the cause of the distortion in perception because of the enhanced neurological activity.

There has been a correlation between Alice in Wonderland symptoms and childhood abuse, specifically Dispersonalisation disorder(DPD). This being that children who are put under stress or physical abuse, placing the child in life-threatening situations; their brains may adapt to respond by causing this depersonalisation disorder, as a defense mechanism because it allows the mind to move away from the present events making it easier to deal with. There was research taken on patients with DPD, where they were tested to see if they met PTSD criteria. The results showed that 51% did, which means there is space for more investigation into the link between DPD and PTSD.

Alice in Wonderland syndrome has been known and researched for over thirty years and is mainly first reported in primary care settings being GP's or Emergency Services, although the syndrome is not particularly life-threatening. It is often hard to research the syndrome as it is difficult to find patients with this syndrome.

Alice in Wonderland syndrome is very hard to diagnose, and is often, for this fact, easily misdiagnosed from conditions such as hallucinations and brain fevers. One study showed that the diagnosis occurred after doing an MRI scan to check for any infectious diseases in the brain. This is when they found there were inflammations in the brain.

There isn't a known treatment that works to relieve Alice in Wonderland syndrome but there are many ways in which patients have been treated for this, but none have been further

investigated. Treatments include; brain stimulation therapy, electrical compulsive treatment, repetitive magnetic treatment, and a migraine diet regiment. The reason there is no treatment for Alice in wonderland syndrome is that the root cause of it is migraines, which can be treated using a variety of methods to alleviate these symptoms and prevent them as a whole.

More clinical investigations are still required to get the full picture of this syndrome, however, as this condition is not life-threatening, further investigations are not taken. Also, the difficulty for the patient to write a history on their experiences, limits the information that can be given to doctors, hence further investigations are not ordered.

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THE TOTTENHAM JOURNAL OF SCIENCE

Hypertrophic Obstructive Cardiomyopathy

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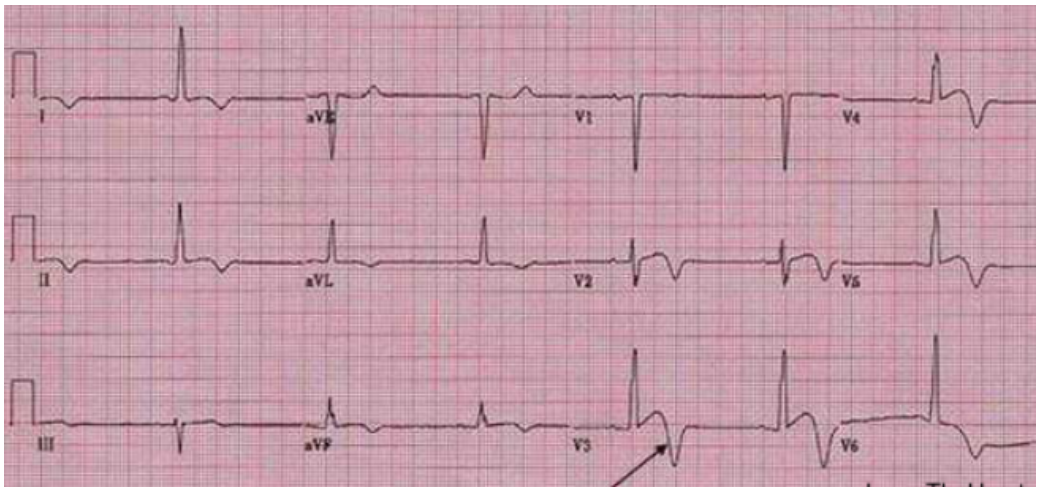
Abstract

Hypertrophic obstructive cardiomyopathy (HOCM) is a disorder where the myocardium becomes abnormally thick. This usually occurs in the interventricular septum that separates the right and left ventricles. In most cases, HOCM is a genetic disorder, caused by several different genes but can arise as a result of spontaneous mutations of the Myocardial cells. The gene most commonly affected is the cardiac Myosin binding protein C. The condition is a prominent cause of cardiac death in young people and seemingly healthy athletes, and symptoms of the condition are often hard to diagnose. Females, however, are more symptomatic, often presenting symptoms at a younger age. HOCM is found almost equally in men and women across races despite this. There is, at present, no cure for HOCM: mild forms of the condition are often treated with dietary and lifestyle changes. Screening of first degree relatives is currently being used to identify patients at high risk of death.

Hypertrophic Obstructive Cardiomyopathy

Hyper Obstructive Cardiomyopathy, (HOCM) is an autosomal dominant genetic disorder in about 60% of cases. The remainder of cases are related to spontaneous mutations. HOCM is caused by several different genes, most of which encode for sarcomere proteins in the contractile apparatus of the myocardial cells.

Hypertrophic Obstructive Cardiomyopathy results in abnormal thickening of the myocardium, also called cardiac muscle. It most commonly occurs in the interventricular septum, the wall separating the left and right ventricles. HOCM can lead to clinical heart failure, life-threatening arrhythmias, mitral regurgitation and sudden cardiac death.



The classic ECG finding in hypertrophic obstructive cardiomyopathy is large dagger-like “septal Q waves”.

Causes:
The causes of heart failure in HOCM are:

1. Diastolic dysfunction - the heart having trouble relaxing between beats, which limits the amount of blood the ventricles can collect for the next heartbeat
2. Mitral regurgitation - leakage of blood backward through the mitral valve
3. Arrhythmia - an abnormal rhythm of the heartbeat
4. End-stage HOCM results in systolic dysfunction, or “burnt out HOCM”

HOCM tends to be an inherited disease. Around 1 in 500 people are affected but far less show symptoms. The most common gene affected is the cardiac Myosin binding protein C, followed by mutations in the cardiac beta-myosin heavy chain. Hypertrophic Obstructive Cardiomyopathy, in most patients, results from asymmetric septal hypertrophy, a condition that occurs when heart muscles cells enlarge, causing outflow obstruction of the left ventricle.

HOCM is a significant cause of sudden cardiac death in young people, including well-trained athletes and affects men and women equally across all races. It is difficult to diagnose and presents a challenge to medical health professionals in evaluating at-risk athletes.

Common symptoms include:

- Shortness of breath
- Chest pain
- Palpitations
- Lightheadedness and fainting

Females tend to be more symptomatic, presenting symptoms at a younger age and thus being more disabled by the condition.. Most patients present in the second or third decade of life. However, some adults may present between the fourth and sixth decades of life.

The dynamic outflow obstruction in HOCM is due to systolic anterior motion of the anterior leaflet of the mitral valve. This is due to impingement of the mitral valve leaflets, where they rub together and cause pain, on the hypertrophied basal septum, located near the left ventricle. The degree of obstruction varies and is dependent upon contractility and loading conditions. In around 25% of patients, the obstruction can exist at rest, but about 70% of patients can be brought about with provocative maneuvers such as regulating diet and exercise. The myocytes, or muscle cells, are not able to align properly and the typical description, pathologically, of heart specimens is that of “myocardial disarray.” Over time, the myocytes are replaced with fibrous tissue which can lead to systolic heart failure, or “burnt out HOCM.”

At present there is no cure for HOCM and treatment is based on the severity of symptoms. Mild forms of the disease can be treated with lifestyle modifications. First line medical treatment for symptomatic HOCM is beta blockers.

Another option would be septal myectomy, which is the surgical treatment of choice in young and healthy patients. Alcohol septal ablation is a newer percutaneous technique (via needle) usually limited to older patients for whom an open procedure would be considered risky.

Mortality rates for HOCM have improved, but still range from 1-6%. Sudden death is the most common cause of death in young people. Studies show that midventricular obstruction is associated with a high risk of apical aneurysm formation, cardiac symptoms, and sudden death compared to patients who did not have the midventricular obstruction.
Death is often sudden and typically associated with a sporting activity or high levels of stress.

Screening of first degree relatives is now done to identify individuals at high risk for death. Patients with HOCM may develop a variety of atrial and ventricular arrhythmias. Heart failure is likely in patients with severe diastolic dysfunction. The condition is progressive and eventually, all patients will develop symptoms.

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THE TOTTENHAM JOURNAL OF SCIENCE

Fibrodysplasia Ossificans Progressiva

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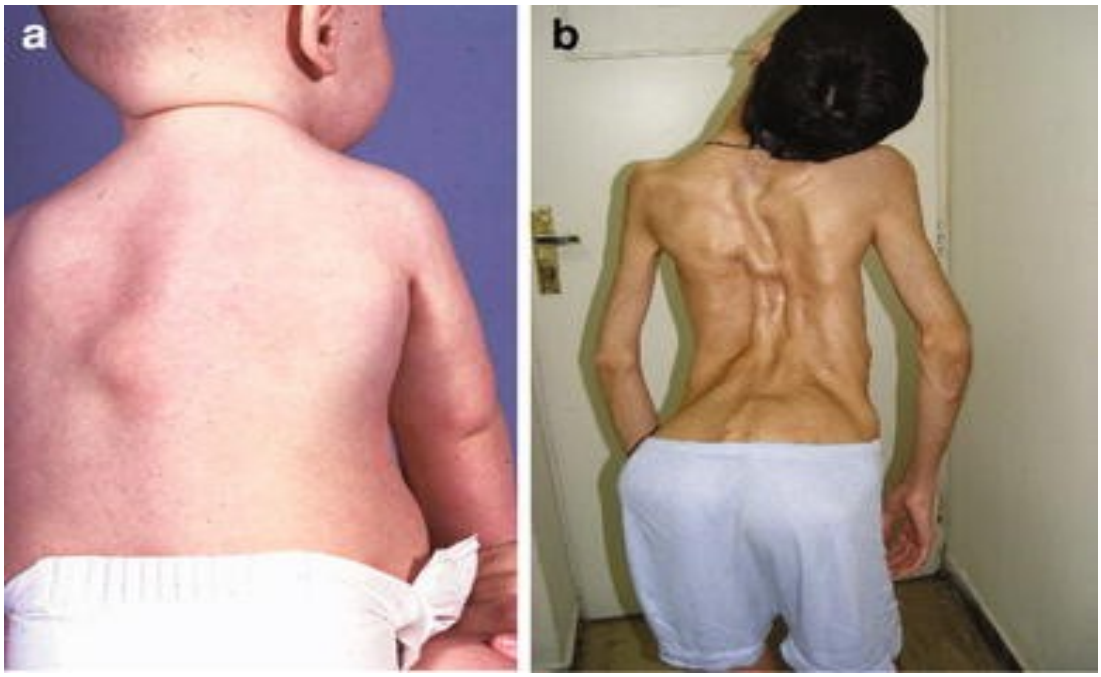
Abstract

Fibrodysplasia Ossificans Progressiva (FOP) is an extremely rare disorder where muscles and connective tissues undergo ossification, the process of hardening into bone. It is caused by the mutation of the ACVR1 gene responsible for the formation of the skeleton in embryos. FOP is often characterised by abnormally large toes and can be identified from the age of ten years old. However, it is the only disease where one organ system becomes another, so is commonly misdiagnosed as cancer or fibrosis. At present, due to the rarity of the disease, there is no cure. Most forms of activity, a common cold or even injections for immunisation can trigger ossification. As a result, previous attempts to surgically remove ossified tissues caused further complications. Drugs that have been effective in treating similar conditions, like isotretinoin and perhexiline have yet to pass clinical trials for treatment of FOP and new drugs have ceased development in the early stages due to multiple deaths.

What is Fibrodysplasia Ossificans Progressiva ?



"Eventually he will become a human statue - a healthy mind locked in a frozen body"

Fibrodysplasia Ossificans Progressiva (FOP) is an extremely rare disorder in which muscles and connective tissue of the body are replaced by bones, through a process known as ossification. This strange phenomenon is caused by a mutation of the ACVR1 gene also known as ALK-2, which is responsible for the formation of the skeleton in the embryo. This mutation causes the emergence of bones outside the skeleton, resulting in a restriction of movement. Consequent to being the only known disease where one organ system changes into another, there is, unfortunately, no current cure or treatment for it. In 2017, there were only approximately 800 cases of FOP recorded. This further highlights the rarity of this disorder. Additional studies have shown that out of 1,600,000 new-born babies, this condition occurs in just 1.

Symptoms and Diagnosis

In FOP patients, the first symptom, being the formation of extraskeletal bones, tends to be recognised at the age of 10, as the bone growth gradually makes its way down the victim, starting from the neck and finally reaching the feet. People with FOP are born with abnormally large toes which makes this disease quite easy to diagnose. However, due to the rarity of this

condition, physicians often misdiagnose this as cancer or fibrosis. There have been unfortunate cases in which the misdiagnosis of FOP as cancer has led to the amputation of limbs, further disabling FOP victims. Other symptoms involve missing joints and limited joint mobility such as the inability to carry out simple jaw assisted functions like eating and verbal communication. Furthermore, The formation of bones around the ribcage causes restrictions in the expansion of the lungs and diaphragm leading to respiratory and cardiovascular complications.

Complications of FOP

With an average life expectancy of 40 years, approximately half the life expectancy of an average person living in the UK, people with FOP are forced to become overly reliant on a carer. Any form of activity that could potentially cause an injury to the muscles has been highly advised to be avoided, as this could trigger ossification around the areas of the injured muscle. Even seemingly harmless things such as injections for immunisation can cause ossification around the jaw, restricting movement. A common cold could also be a trigger for muscle formation around the lungs.

A case study documented the trials and tribulations of a 7-year-old FOP patient and her mother. It was evident that the patient, named Luciana, had struggled with basic tasks, such as a simple itch. She required her mother's assistance for many things, causing frustration daily; a simple itch was a gruelling task which she could not overcome by herself.

The future of treatment for FOP

Finding a cure for a genetic disease is an extremely difficult process that has to pass a large number of extensively assessed trials. Scientists and doctors have explored many forms of possible treatments to either ease the symptoms or completely get rid of the underlying causes; however, none have been very successful. Any attempts to surgically remove the ossified bones caused further development of new extraskeletal bones.Many different drugs that are used to treat conditions that have similarities to FOP such as perhexiline, isotretinoin and many others have unfortunately failed clinical trials.

Despite all this, there are many other pharmaceutical companies that are at different stages in their development of a potential treatment for this disease. Currently, there are many drugs in development, 3 of which are called Garetosmab, Paloverotene and BLU-782. Unfortunately, due to the death of multiple patients, all trials were immediately stopped, emphasising the difficulty of drug development.

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