Key Points

1. In studying how syrinxes form, researchers have looked at the large picture of CSF flow and at the molecular level, the role the immune system might play
2. Study created syrinxes in 30 rats by injecting kaolin into their spinal cords
3. Rats were killed and their spinal cords examined at 3 days, 1 week, and 4 weeks after injection
4. Found large number of macrophages in the central canal near the injection site
5. Authors speculate that this immune response plays a key role in the formation of syrinxes
6. Future research will look at what happens if the production of macrophages is suppressed

Definitions

bone marrow - soft tissue inside of bones which produces blood cells

central canal - the tube like center of the spinal cord; the central canal is open in childhood and slowly closes as people age

cerebellar tonsils - portion of the cerebellum located at the bottom, so named because of their shape

cerebellum - part of the brain located at the bottom of the skull, near the opening to the spinal area; important for muscle control, movement, and balance

cerebrospinal fluid (CSF) - clear liquid in the brain and spinal cord, acts as a shock absorber

Chiari malformation - condition where the cerebellar tonsils are displaced out of the skull area into the spinal area, causing compression of brain tissue and disruption of CSF flow

chimera - an animal which contains the cells, or tissue, from another animal; named after the

The Damage That Syrinxes Cause

In trying to understand how and why syrinxes form, many researchers have focused on the large-scale role that CSF flow plays. While this is understandable given that fluid must somehow collect in a syrinx cavity, other researchers have focused their attention on the microscopic world instead; choosing to study what role the body's own immune system might play in the poorly understood world of syrinxes.

Over the years, both autopsy and animal studies have shown that there is marked immune system activity near syrinxes. Specifically, researchers believe - especially with post-traumatic syringomyelia - that some type of inflammation response might be involved. Macrophages, a type of immune cell which acts as a scavenger and essentially eats dead tissue, have been identified as being present in large number near syrinxes, however their exact role in syrinx formation and progression is not yet known.

If macrophages, or some other type of immune cell, turn out to play an important role in the formation of syrinxes, not only would it shed light on the underlying process, but it could potentially provide for a new avenue of treatment. If the type and origin of the immune cells can be identified, it may also be possible to reduce their presence and limit the development and growth of syrinxes.

With this in mind, Dr. Gabriel Yin Foo Lee and his colleagues at the Royal Adelaide Hospital and the University of Adelaide, in Australia, decided to create syrinxes in rats and then examine them for the presence of macrophages. They published their work in the January 15, 2005 issue of the journal Spine.

Dr. Lee suspected that the macrophages which had previously been seen near syrinxes were coming from bone marrow, the source of many types of immune cells. In order to differentiate bone marrow macrophages from other sources of immune cells, Dr. Lee's team created what are known as bone marrow chimeras. In Greek mythology, the chimera was a fire-breathing monster with the head of lion, the body of a goat, and the tail of a serpent. In the modern laboratory, a chimera is an animal which contains cells or tissue from another animal.

Dr. Lee's group destroyed the immune producing bone marrow of their rats using radiation and then replaced it with genetically distinct bone marrow from different rats. This way, they would be able to tell the difference between immune cells produced from the bone marrow and those from other sources.

After letting the rats recover for six weeks, the research team used a well-recognized method to create syrinxes in the rats. Namely, they injected kaolin into their spinal cords. The rats were then divided into three groups (10 rats each) and their spinal cords and spleens were removed for examination at 3 days after the injection, 1 week after the injection, and 4 weeks after the injection.

The team found that the rats did indeed show signs of swelling in the central canal at 1 week, and at 4 weeks the central canals of some rats were actually blocked by large aggregates of the kaolin covered in macrophages.

In studying the spinal tissue more closely, the research team used special stains to help identify different immune cells and counted them manually. They found significant evidence of inflammation and immune response at the 3-day mark, with the inflammation peaking at the 1 week mark. They also found two distinct types of immune cells. One type was standard macrophages created by the bone marrow, but they also identified a second, smaller type of microglial cells. Microglial cells are cells from the fine, connective tissue in the spinal cord which have turned into cells that engulf and digest foreign invaders.

Perhaps most importantly, the team found that after 4 weeks, in a number of rats, their immune response - the action of the macrophages and microglial cells - had essentially created an obstruction in the central canal. The authors speculate - and take pains to point out this is a theory - that the immune cells that respond to the kaolin injection in the tissue of the spinal cord (the parenchyma) are carried into the central canal via the natural CSF flow. This then obstructs the local flow of CSF and the central canal starts to swell. Macrophages then continue to accumulate, causing more swelling. Eventually, when the macrophages disperse, a syrinx cavity remains.

While their theory remains just that, it does seem likely given the accumulating evidence that the immune system - perhaps in the form of macrophages and/or microglial cells - plays a role in the formation of some type of syrinxes. Dr. Lee and his team plan to continue their work by seeing what happens in terms of syrinx formation if they deplete the number of macrophages at the site.

If they are successful in showing that they can impact the formation of a syrinx by reducing the presence of specific immune cells, they may open up a new avenue of treatment, especially for the difficult to treat post-traumatic syringomyelia.

mythological creature

decompression surgery - general term used for any of several surgical techniques employed to create more space around a Chiari malformation and to relieve compression

immune response - how the immune system reacts to foreign substances

kaolin - a fine white clay, used to create syrinxes in rats

macrophage - type of immune cell which scavenges dead tissue by engulfing it

microglia - fine, connective tissue in the brain and spinal cord which turns phagocytic

phagocytic - a cell that engulfs and digests debris and foreign invaders

parenchyma - in this case, the actual tissue of the spinal cord

spleen - an organ which plays an important role in the immune system and is a reservoir for macrophages

syringomyelia (SM) - neurological condition where a fluid filled cyst forms in the spinal cord

syrinx - fluid filled cyst in the spinal cord

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