

Commentary

How Sperm gets Damaged or What Causes Sperm DNA Fragmentation?

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INTRODUCTION

The genetic material of sperm can be damaged in a variety of ways, and it can happen at any stage during the process of making and storing sperm.

Errors or damage that occurs during the "condensation" process

The genetic material within sperm condenses during spermatogenesis (the sperm manufacturing process). To assemble itself tightly in the sperm's head, DNA wraps around a few particular proteins. This permits a big amount of DNA to fit into a compact space, potentially protecting the DNA from harm.

However, this procedure has the potential to cause harm [1]. To begin with, there is a significant amount of genetic material that must be compacted tightly within the nucleus of the sperm; this twisting may induce actual breaks in the DNA. Furthermore, if the processes that package this genetic material have flaws, such as a lack of proteins essential to help the condensation process, DNA will be more vulnerable to external pressures.

Stress due to oxidation (Oxidative Stress)

Free radicals are among the "outside forces." Free radicals, also known as reactive oxygen species (ROS), are unstable chemicals that occur naturally in everyday life. ROS are normally not harmful at low levels and may even be beneficial to cells. However, if left unregulated, free radicals can harm other components in our cells, including DNA. "Oxidative stress" is the term for this type of damage.

Antioxidants, which are created naturally by our systems and absorbed through food or supplements, are normally used by our bodies to neutralise harmful chemicals and prevent damage. In reality, antioxidants such as vitamin E, vitamin C, and glutathione are known to be abundant in sperm to protect them from oxidative stress. Other regions of the male reproductive system, such as the epididymis, where sperm is stored, also create antioxidants.

Exposure to environmental pollutants such as pesticides, heavy metals, or pollution; radiation; infections; smoking tobacco; and drinking alcohol are all known to raise the presence of free radicals beyond what our bodies can normally tolerate. Antioxidant levels, on the other hand, will be insufficient to fight free radicals if they are too low, which might be related to a poor diet.

Oxidative stress occurs when the delicate balance between free radicals and antioxidants is disrupted. The main cause of sperm DNA fragmentation, according to researchers, is oxidative stress.

According to studies, sperm demonstrate increased levels of DNA damage as oxidative stress increases; at the highest levels of oxidative stress, significant DFI is reported accompanying sperm motility loss [2-4].

Abortive Apoptosis

Apoptosis is a type of cell death that occurs naturally throughout growth and development. Consider it a "self-cleaning" system that clears the body of unwanted, damaged, or contaminated cells. Despite the fact that apoptosis includes cell death, it is helpful and necessary for the overall health of the organism. The presence of a certain protein, Fas, which promotes apoptosis, can identify a cell that has been tagged for "deletion."

How do sperm cells with DNA damage make it into the semen if the body is continually wiping out faulty cells? It appears that the body can sometimes recognise sperm with DNA damage and "earmark" them with Fas, but the process is disrupted somewhere along the route, allowing defective sperm to escape. Abortive apoptosis is the term for this. We don't know why this happens, but we do know it affects fertility: in one study, males with defective sperm parameters had higher levels of Fas on their sperm.

These mechanisms are inextricably linked. Instead of a single failure generating sperm DNA fragmentation, it's more likely that a sequence of failures results in significant amounts of DNA damage. For example, if sperm DNA is not properly packed, it is more susceptible to oxidative damage [5]. Because there aren't enough antioxidants in the body, oxidative stress damages sperm, and the body can't completely clear the damaged cells.

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