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Short Communication

Current Knowledge Regarding the Biological Methods of Assessing DNA Damage in Humans

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ABSTRACT

This work summarizes the information available currently regarding the biological methods of assessing DNA (Deoxyribonucleic Acid) damage in humans. The methods include the comet assay (for determining single-strand DNA breaks, alkali-labile sites, and cross-links), the micronucleus assay, cytogenetic assays (which include the sister chromatid exchange assay and chromosomal aberration assay), oxidative DNA damage assays (including the measurement of oxidized bases like 8-oxo-7, 8-dihydro-2'-deoxyguanosine), and DNA repair assays. However, selecting the best method will depend on a number of factors, including the study's objectives, the type of DNA damage being measured, the resources at hand, and the study's size. A more comprehensive understanding of DNA damage and its potential effects on human health may also result from combining different techniques. Assay standardization and continuous technological advancements will enhance our ability to accurately assess DNA damage in humans.

Keywords: DNA damage; Humans; Comet assay; Cytogenetics; Oxidized bases

DESCRIPTION

As a result of exposure to endogenous and exogenous factors like metabolic processes, Ultraviolet (UV) radiation, and environmental pollutants, DNA damage is a physiological and inevitable phenomenon. Determining potential health risks and identifying individuals who may be more susceptible to specific diseases require an understanding of the degree of DNA damage. As a result, numerous techniques have been created to evaluate DNA damage in humans, facilitating a deeper comprehension of the damage mechanisms and possible mitigation approaches [1,2]. The various biological techniques for evaluating DNA damage in humans will be summarized in this editorial, along with their benefits and disadvantages.

Biological methods of assessing DNA damage in humans

A reliable and popular technique for determining single-strand DNA breaks, alkali-labile sites, and cross-links is the comet assay, also referred to as the single cell gel electrophoresis assay. Cells are embedded in agarose on a slide, and then electrophoresis, alkaline unwinding, and lysis are performed on the cells. Fluorescent dyes can be used to visualize the comet-like tail that forms when damaged DNA migrates away from the nucleus. The amount of DNA damage is correlated with the comet tail's length. This process uses a small amount of biological material, is reasonably easy to be accomplished, and is adequately economic. Additionally, it can be modified to work with various human cell types, such as sperm cells, buccal cells, and peripheral blood lymphocytes. However, large-scale studies that use the comet assay are limited due to the method's subjective nature, time-consuming constitution, and susceptibility to inter-individual variation [3].

Moreover, based on the presence of micronuclei, which are small nuclei formed during cell division as a result of chromosome breakage or spindle dysfunction, the micronucleus assay is a widely used technique for evaluating DNA damage in human cells. Using immunofluorescent staining, these micronuclei can

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be seen and their frequency can be measured. Numerous types of DNA damage, such as chromosomal breaks, aneuploidy, and clastogenic events, can be found using this technique. It can be applied to various cell types, such as buccal cells, blood cells, and tissues. Nevertheless, the micronucleus assay is not appropriate for large-scale studies due to its labor-intensive, time-consuming, and skilled personnel requirements [4].

Besides, cytogenetic assays, such as the chromosomal aberration assay and sister chromatid exchange assay, are used to measure structural and numerical chromosomal aberrations resulting from DNA damage. In order to observe any alterations in chromosomal structure or exchanges between sister chromatids, the cells in these assays are exposed to a mutagen for a duration of time before being removed and stained. Point mutations, deletions, duplications, and translocations are just a few of the many types of DNA damage that these sensitive methods can detect. They are not appropriate for large-scale studies, though, because they take a lot of time, need specialized equipment, and are subject to inter-individual variability [5,6].

Furthermore, one frequent type of DNA damage which can result in mutations, genomic instability, and cell death is oxidative DNA damage. As a result, a number of assays, including the determination of oxidized bases like 8-oxo-7, 8-dihydro-2'-deoxyguanosine (8-oxodG), have been developed to quantify oxidative DNA damage. These assays use methods like Enzyme-Linked Immunosorbent Assay (ELISA) and High-Performance Liquid Chromatography (HPLC) to quantify the amounts of oxidized bases in biological samples. These techniques can be used to measure the amount of oxidative DNA damage in various human biological samples, such as blood, urine, and tissues. They are also very sensitive and specific. Notwithstanding, they are not appropriate for large-scale studies because they need specialized equipment and skills [7].

An additional method of evaluating DNA damage is to measure an individual's capacity for DNA repair. In order to preserve genomic stability and prevent mutations that could cause diseases, DNA repair is essential. A number of assays have been developed to quantify the capacity for DNA repair, such as the host cell reactivation assay, which assesses the capacity of cells to repair damaged DNA following UV radiation exposure [8]. Additional techniques include the single-cell gel electrophoresis assay and the unscheduled DNA synthesis assay, which estimate the rate of DNA repair by incorporating labeled nucleotides into the damaged DNA [9,10]. Large-scale studies can use these assays due to their high specificity, but they do need specific equipment and experience.

CONCLUSION

In conclusion, there are a number of biological techniques for evaluating human DNA damage, each with strengths and weaknesses. The aims of the study, the type of DNA damage being measured, the resources available, and the study's size all play a role in selecting the best approach. Combining various techniques may also lead to a more thorough understanding of DNA damage and its possible effects on human health. Our capacity to precisely assess DNA damage in humans will be further improved by ongoing technological advancements and assay standardization.

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