Optical genome mapping: Looking beyond karyotyping

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Optical genome mapping (OGM) is an advanced technology that delivers a distinct view of genome structure. It presents numerous benefits compared to conventional sequencing techniques, as well as karyotyping in identifying large-scale structural variations (SVs). SVs refer to significant alterations in the structure of a genome that go beyond the changes of individual nucleotides.[1] These variations can have substantial effects on gene function and are linked to various genetic diseases and disorders.[2]

There are several types of SVs, including copy number variations, such as duplications or deletions, translocations, inversions, fusions, and complex rearrangements.[3]

OGM has evolved as an innovative technology that offers high-resolution insights into genomic structures. Unlike conventional sequencing techniques such as next-generation sequencing, which concentrate on decoding short DNA segments, OGM allows for the direct visualization of long DNA strands, delivering a comprehensive, large-scale perspective of the genome's organization.[4] This capability makes it an effective tool for detecting SVs, which may be overlooked by other techniques. Applications of OGM are mostly in cancer genomics to detect chromosomal rearrangements and decode rare genetic disorders. OGM can also be applied in plant science, where large-scale SVs may contribute to traits such as disease.[5-7] In recent years, a surge in OGM analysis has been witnessed, primarily due to the higher resolution in detecting SVs. Further, with longer reads, OGM helps in the discovery of complex and rare genomic variations.[8] OGM protocol employs a paramagnetic disk designed to capture DNA during wash steps, which helps to minimize the shearing forces. Consequently, the resulting DNA fragments range from approximately 150 kilobases (kbp) to megabases (Mbp) in length, which is around 5–10 times longer than the average fragment size obtained through conventional DNA isolation techniques, making them ideal for OGM.

To summarize, OGM serves as a robust technology that facilitates the direct observation of extensive SVs within the genome, offering essential insights for genomic research, clinical diagnostics, and the advancement of personalized medicine.[9,10]

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