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Unlocking the Future of Anesthesia: The Critical Role of Exosomes

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Dear Editor,

Anesthesia is an integral component of most surgical procedures, administered as general anesthesia, regional anesthesia, or monitored anesthesia care. Its primary goals are to improve patient and surgical conditions by minimizing stress responses, controlling anxiety, managing pain, and sometimes providing muscle relaxation. Despite its benefits, the side effects of anesthesia have not yet been fully addressed.

Promising molecular research, involving bioactive agents that interact with specific proteins and target unique sites, shows potential in significantly reducing the side effects of anesthetic drugs. Exosomes, which are bioactive factors, have demonstrated positive roles in repairing damaged tissues or organs. For instance, exosomes derived from cerebrospinal fluid have been shown to enhance nerve cell proliferation and support the repair of neurons (1). Additionally, research indicates that these bioactive agents can mitigate neurotoxicity caused by anesthetic drugs by repairing nerve cell damage (2). Exosomes from athletes have also been used to stabilize cardiac conditions (3). Furthermore, exosomes have been found to reduce post-surgical side effects, including pain relief (4), arrhythmia reduction (5), and improvements in cognitive and sleep disorders (2).

Given these findings, exosomes represent bioactive factors that could be efficiently employed to enhance patient health. The expansion of exosome use in anesthesia holds significant promise for advancing the field and improving patient safety.

In addition, due to the involvement of similar biological pathways in the repair of tissue and organ injuries, exosomes can be considered as a supplementary option for local anesthesia. The protective function of exosomes in preventing and repairing organ damage is mediated through several biological mechanisms, including the reduction of fibrosis, improvement of hypoxic injury, inflammation control, and cell regeneration (6). Exosomal adjuvants derived from certain cell lines may even outperform current local anesthetic adjuvants, such as epinephrine, in enhancing anesthesia's effectiveness. However, despite the promising performance of exosomal adjuvants, their widespread use requires further laboratory and clinical research to ensure the safety and efficacy of exosome-based products.

The exosomal adjuvants successfully used in studies have been derived from various cell sources. For instance, pain control using macrophage-derived exosome adjuvants (7), improved cardiac function through exosomes obtained from cardiomyocytes after exercise (3), and the development of functional lung exosomes using mesenchymal stem cells (8) highlight the diverse origins of exosomes. One of the key challenges in expanding the use of exosomes is the high cost associated with sourcing them from different cell types. Currently, due to the broad potential of mesenchymal stem cells in various research areas, many scientists worldwide are focusing on these sources to develop therapeutic exosomes (9).

So far, few studies have investigated the function of exosomes derived from human mesenchymal stem cells, with most research focusing on animal models such as mice and rats. Exosomes have shown potential in enhancing the regeneration of injured tissues. However, it is important to recognize that significant research is still needed to fully understand their clinical efficacy and to implement them in routine medical practice (10).

In conclusion, exosomes are bioactive agents with the potential to heal and prevent tissue and organ damage, offering considerable promise in the development of medications used in anesthesia and in the prevention and treatment of related side effects. Their unique attributes, such as biocompatibility, detectability, traceability, and adaptability, position exosomes as a valuable option in biotechnological and multidisciplinary medical research.

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