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Review Article

Impact of nutrition on wound healing

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ABSTRACT

Whether from an unintentional damage or surgical intervention, wounds require the cooperation of a complex network of blood cells, tissue types, cytokines, and growth hormones to heal. Increased cellular activity as a result leads to a higher metabolic need for nutrients. Inadequate nutrition can delay the healing process, and a number of nutrients needed for wound repair can speed up the healing process. Inflammatory, proliferative, remodelling, and wound closure are the four stages of wound healing. The wound must be cleaned and clot during the inflammatory period. Through tissue growth, the proliferative phase creates the wound bed. Collagen becomes more robust during the remodelling process. Nutritional integrity is essential at all times. Calcium, zinc, vitamins K, A, and E, and proteins are necessary during inflammation. Amino acids, B vitamins, fats, zinc, and iron all have a role in proliferation. However, this review highlights regarding possible roles for nutrition in wound healing.

1. Introduction

Sufficient nourishment is essential for the healing of wounds. Nutrients are needed by the skin for a number of biologic processes to continue and grow. Proficiency in cellular repair mechanisms, components (such as growth factors and cytokines), and an environment that facilitates cell division, motility, and differentiation locally are all necessary for wound healing.[1] Sufficient quantities of nutrients are required for the synthesis of proteins, nucleic acids (DNA and RNA), and other components essential in the maturation and differentiation of functional tissues.[2] A complicated web of interactions between various cell types, cytokine mediators, and the extracellular matrix is involved in wound healing. The stages of hemostasis, inflammation, proliferation, and remodelling are all typical for wound healing. Although the wound healing process is ongoing, each step of the process is different and overlaps with the subsequent phase. The patient's general health and nutritional state have an impact on the healing process of the damaged tissue because proper blood and nutrient delivery to the site of damage is necessary for successful wound healing. The goal of wound care is to minimize the patient's pain, discomfort, and scarring while healing the wound as quickly as possible. A fine, flexible scar with high tensile strength is needed at the site of wound closure.

For wound patients to receive effective care, it is essential to comprehend how diet affects wound healing. Numerous dietary cofactors, such as zinc, arginine, glutamine, glucosamine, vitamins A, C, and E, have been linked to tissue regeneration by researchers who have studied the intricate dynamics of tissue repair.

1.1. The four phases of wound healing

When tissue is injured, the body responds by first purging the wound of foreign objects and devitalized tissue, which

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prepares the area for later tissue regeneration and healing. Vasoconstriction and hemostasis are temporary and part of the first vascular response. Strong vasoconstriction lasts for five to ten minutes, after which there is active vasodilation and an increase in capillary permeability. Numerous growth factors and cytokines are secreted by platelets aggregating within a fibrin clot, which pave the way for a systematic sequence of events that ultimately result in tissue restoration.

The inflammatory phase, which is the second stage of wound healing, is characterized by erythema, swelling, and warmth. It is also frequently accompanied by pain. Increased vascular permeability brought on by the inflammatory response causes neutrophils and monocytes to migrate into the surrounding tissue. The neutrophils serve as the body's initial line of defense against infection by consuming waste and microbes. If the wound is clean, neutrophil migration stops within the first few days after the damage. The late inflammatory phase may be hampered if the acute inflammatory phase lasts longer than expected for any number of reasons, including wound hypoxia, infection, malnutrition, pharmaceutical side effects, or other immune-related issues. During the advanced stages of inflammation, monocytes in the tissue changed into macrophages, which scavenge tissue debris, break down and eliminate bacterial infections, and eliminate any neutrophils that remained. Through the secretion of several growth factors that promote cell migration, proliferation, and the creation of the tissue matrix, macrophages initiate the transition from wound inflammation to wound repair. Granulation tissue development and epithelialization are the main features of the proliferative phase that follows. The length of time it takes depends on how big the wound is. The migration and activation of wound fibroblasts, which produce a variety of substances necessary for wound repair, including glycosaminoglycans (primarily hyaluronic acid, chondroitin4-sulfate, dermatan sulfate, and heparan sulfate) and collagen, are stimulated by chemotactic and growth factors released from platelets and macrophages. For cell movement, this creates an amorphous, gel-like connective tissue matrix.

In order to supply metabolic requirements, new capillary development must advance into the wound alongside the fibroblasts. The strength of newly formed capillary beds and the integrity of the vasculature are due to the production and crosslinking of collagen. In patients with normal coagulation parameters, nonspecific post-operative bleeding has been linked to improper collagen fiber cross-linking. Fibroblast activity in the early stages of the proliferation phase is restricted to cellular migration and replication. Measurable volumes of collagen are synthesized and secreted by the expanding bulk of fibroblast cells around the third day following injury. The amount of collagen increases steadily for around three weeks. The tensile strength of the wound is determined by the quantity of collagen secreted during this time. Wound remodelling, the last stage of wound healing, involves the rearranging of newly formed collagen fibers to create a more ordered lattice structure that gradually raises the tensile strength of the wound. After four weeks, the remodeling process can take up to two years to reach 40–70% of the strength of undamaged tissue.[3]

1.2. Micronutrients and wound healing

1.2.1. Amino-acids

Numerous reviews have been conducted on the micronutrients involved in the process of wound healing.[4–6] Arginine and glutamine are two amino acids that are crucial for the healing of wounds. The first is a precursor of proline and nitric oxide, both of which are necessary for the production of collagen.[7,8] and the inflammatory process.[9] Moreover, arginine promotes T cell activation and growth hormone synthesis and secretion.[10,11] The suggested dosage of arginine supplementation in wound patients who consume enough protein is 4.5 g/day, however it is ineffective when there is a protein shortage.[12] Due to its effects on metabolism, enzymology, immunity, and antioxidants, glutamine has multiple functions.

It does this by up-regulating the expression of heat shock proteins in wounds, protecting against the danger of infectious and inflammatory consequences.[13] Additionally, glutamine is a precursor of glutathione, an antioxidant and a necessary component in a number of enzymatic processes that stabilize cell membranes and facilitate the passage of amino acids across them.[14] Furthermore, glutamine appears to play a role in the inflammatory stage of wound healing through controlling the formation of superoxide, leukocyte apoptosis, antigen processing, and phagocytosis.[15] Regarding arginine, the advantages of supplementing with glutamine remain debatable.[16] and complicated by supplement combinations.[17]

1.2.2. Vitamins

Without a doubt, the micronutrients that have been studied the most in the process of wound healing are vitamins. During the inflammatory phase, vitamin A deficiency affects the activity of B and T cells as well as the synthesis of antibodies. In the proliferative and remodelling phases, it also reduces granulation tissue formation, collagen synthesis, and epithelialization. Furthermore, by binding to retinoic acid receptors, vitamin A appears to function as a hormone that modifies the activity of melanocytes, fibroblasts, and epithelial and endothelial cells. Because vitamin A stimulates fibroplasia and epithelialization, it is typically applied topically to treat dermatological problems. To prevent toxicity, it has been suggested that patients with wounds take a short-term supplement of 10,000–25,000 IU/day. It's interesting to note that vitamin A supplementation down-regulates TGF-

β and insulin-like growth factor-1 (IGF-1) to prevent the delay in wound healing brought on by corticosteroids in the treatment of inflammatory illnesses.[18] The B vitamins—thiamine, riboflavin, pyridoxine, folic acid, pantothenate, and cobalamins—are necessary cofactors in enzyme activities that result in the production of leukocytes and in the anabolic processes that repair wounds. Among these, the manufacture of collagen also requires pyridoxine, cobalamins, thiamine, and riboflavin. Therefore, vitamin B deficiency increases the likelihood of infection complications by affecting white blood cell and antibody formation, which in turn affects the wound healing process indirectly.[19] With several functions in cell migration and transformation, collagen synthesis, antioxidant response, and angiogenesis, vitamin C appears to play a part in wound healing. It takes part in the recruitment of cells to the wound and their conversion into macrophages during the inflammatory phase. Vitamin C creates additional boundaries between collagen fibers during the creation of collagen, which strengthens and stabilizes the collagen matrix. A lack of vitamin C may make newly formed blood vessels more brittle by preventing injured cells from producing free radicals. The ubiquitous expression of vitamin D in multiple tissues, along with its receptor, or VDR, regulate the transport across epithelial barriers and maintenance of structural integrity. According to its functions, current data demonstrating vitamin D deficiency in individuals with pressure ulcers and veins has raised the possibility that vitamin D has a role in the process of wound healing.

To learn more about the potential applications of vitamin D supplementation in wound care, additional research is advised. While most vitamins have positive benefits on wound healing, vitamin E may have adverse effects on the inflammatory phase, antioxidant response, and collagen formation.[20] Furthermore, it seems that vitamin E mitigates the advantages of vitamin A supplementation in the treatment of wounds.

1.2.3. Minerals

Because they function as antioxidants, metalloenzymes, and structural components of enzymes, a number of minerals have an impact on the healing process of wounds. Zinc is one of these, and it is necessary for DNA replication in cells that divide quickly, like fibroblasts, epithelial and inflammatory cells. Zinc activates cells and produces antibodies during the inflammatory phase, promoting immune response and reducing susceptibility to viral problems. By promoting the activity of relevant enzymes, it is crucial for collagen synthesis, fibroblast proliferation, and epithelialization throughout the proliferative and remodelling stages.[7] The effects of supplementing with 40–220 mg of zinc per day for 10–14 days.[21] are still being debated, but it may be helpful for individuals who are zinc deficient. It's interesting to note that applying zinc topically to surgical incisions speeds up the healing process.[22]

2. Discussion

When tissue regeneration and repair are supported by a physiological environment, wound healing happens fast and effectively. Patients' nutritional state during trauma or surgery affects the biochemical pathways required for the phases of normal healing to transpire. Malnourished or undernourished people heal more slowly and are more likely to experience problems both during and after surgery. While the impact of optimal levels of dietary and supplemental nutrient intakes for wound healing is relatively unclear, the association between malnutrition and poor wound healing is widely recognized.[23–25]

3. Conclusion

Hydration and nutrition play a key role in the healing of wounds. While it is unrealistic to focus on any one nutrient in isolation, a few seem to be especially crucial for the healing of wounds. The primary building blocks for tissue growth, renewal, and injury repair are proteins and amino acids. In epidermal and dermal tissues, fats supply energy and substrates for growth, maturation, and hemostasis. In addition, the body needs at least 20 compounds that resemble vitamins, 16 minerals, and trace elements to maintain normal physiological processes.

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None.

5. Conflict of Interest

None.

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