

Bioactive wound Closure Devices are highly Demanded

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Volume 1 Issue 5- 2018

Received Date: 18 Sep 2018

Accepted Date: 06 Oct 2018

Published Date: 14 Oct 2018

1. Opinion Piece

Wounds are a serious matter that can diminish an individual's overall quality of life due to physiological, physical and functional complications. In addition to this, there is also a great financial burden that accompanies wounds. In the United States alone, \$25 billion is spent annually on wound treatment [1]. There are multiple factors, such as rising health care costs and an aging population, that are contributing to the growth of this expense and thus, heightening the significance of the matter [1]. The combination of both the health and financial components leaves many people in desperate need of a solution. Altogether, the economic burden affects 65 million Americans while a total annual cost of 39 billion dollars is lost in wages as a direct outcome of wounding [1]. Not only is this deficit accumulated due to young adults losing working time, but it is also due to the early retirement of the elderly population [1]. Clearly, these effects are quite expansive in terms of the scale of people and the ways in which they leave an impact.

Various types of postoperative complications can occur even when wounds have been treated promptly and properly. For example, wound infections are one of the costliest postoperative complications and they are the leading source of bacteria spreading in hospitals [1]. They also directly impact the affected patient by resulting in excessive and long-term inflammation [2] as well as continuous pain and/or itchiness [3]. Another serious postoperative complication of wounds is dehiscence. Mortality rates due to wound dehiscence have been reported to be anywhere between 14%-50% [4]. In addition to this, incisional hernia as a result of wound dehiscence was reported in 43% of patients [2]. There are many other risk factors associated with wound dehiscence including hypoproteinemia, malignant disease, anemia, and peritonitis [5]. Furthermore, dehiscence exposes the site of the wound to bacteria and other pathogens, resulting in infection. This occurrence affects 50% of all wound dehiscence patients and can disrupt the healing process [5]. Leaving the wound open could potentially lead to septicemia or blood poisoning and if conditions get bad enough, this could develop into a much more severe case where the infected body part may need to be amputated [3].

All wounds should definitely be approximated with medical devices, such as sutures, staples, and sealants. Clean wounds without a loss of skin or soft tissue insufficiency, such as incised wounds caused by clean sharps and some surgical incisions, do not bear the extra tension. These wounds can be easily closed with common medical devices and usually heal fast and well. However, many other types of wounds are accompanied by the loss of skin, soft tissue insufficiency, and /or infec

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tion, which are difficult to close and always result in complications and massive scar formation. For example, in cleft lip and palate repair, sutures are used to position and reshape the nasal deformity and extend down to the upper lip to approximate the cleft in its entirety. However, due to the congenital soft tissue insufficiency, excessive tension in the repaired cleft greatly increases the difficulty of wound closure. In patients with contaminated wounds, which is generally seen in car accidents, earthquakes and fall injuries, the risk of wound infection is high. This may, in turn, lead to necrosis of the adjacent tissue and wound dehiscence. Excessive mechanical loading across wounds, resulting in hypertrophic scarring or wound separation is therefore particularly prevalent in surgeries due to anatomic and surgical factors, and contributes substantially to postoperative morbidity. Currently, patients who wish to minimize scar formation during post-surgical wound healing have two main treatment options, local corticosteroid injection and radiation therapy. However, both of these options have shown inconsistent efficacy and undesirable side effects. Local corticosteroids reduce wound strength while increasing dehiscence risks, pigmentary changes, granulomas, and skin atrophy [6]. Radiation therapy causes growth inhibition, decreased wound strength, and increased the long-term risk of tumor formation [7]. Clearly, there is a significant need for better and safer strategies to prevent or minimize scar formation, without compromising wound strength. Unfortunately, current wound closure devices, including antibiotic-coated ones, can only approximate tissue in a mechanical, but non-biological fashion. As such, conventional wound closure devices are entirely dependent on the local biology of fibroblast migration, as well as collagen deposition, organization, and cross-linking, to help surgical tissue healing and endogenous wound tensile strength reestablishment.

Meanwhile, developing innovatively bioactive wound closure devices that can meet the urgent needs of improved wound healing will bring incredible economic benefits. In 2013, the wound closure field secured revenues of ~\$7.3 billion [8], and sutures dominated the wound closure market. The global surgical sutures market is expected to reach \$4.40 Billion by 2021 from \$3.46 Billion in 2016, at a compound annual growth rate (CAGR) of 5% during the forecast period [9]. The growth of this market is mainly driven by factors such as a growing number of surgical procedures, the favorable reimbursement scenario for a number of surgical procedures, and the launch of advanced wound closure devices. Given the 5.8 million reconstructive surgery procedures and 1.7 million cosmetic procedures performed each year in the US, the market size for a bioactive wound closure device that accelerates wound tensile strength reestablishment and reduces

scar formation is expansive [10].

Overall, due to the lack of wound closure devices that can prevent scar formation and an unavailability of successful treatment options, there is a large demand for developing novel bioactive wound closure devices. A device that permits successful healing while limiting further postoperative complications and unwanted scarring is certainly necessary.

2. Acknowledgments

This study was financially supported by NIH-NIDCR Grant (#R01DE026080), Plastic Surgery Foundation, Translational Research Grant (#571906), and Center for Dental, Oral, & Craniofacial Tissue & Organ Regeneration (C-DOCTOR) ITP Team Award (#U24DE026914). The content is solely the responsibility of the authors and does not necessarily represent the official views of the funding agencies.

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