Journal of Blood Disorders & Transfusion
ISSN: 2155-9864
OPEN ACCESS Freely available online
Short Communication

Wound Pathophysiology: Insights of Ca^{2+} Signaling and Cellular Senescence Mechanisms in Healing, and Regeneration

Rajiv Kumar*

Department of Chemistry, National Institute of Medical Science, India

ABSTRACT

Cellular senescence and calcium signaling are interrelated phenomena of cellular events. As, cellular senescence is associated with stress, alongside it, intracellular calcium signaling has a concern with cellular senescence. Henceforth, both events participate in wound regeneration and governed few of its phases (re-epithelialization, tissue remodeling, inflammation, and granulation). Despite it, mitochondrial Ca^{2+} uptake influences the phenomena of fibroblast and my fibroblast differentiation. Quantitative imaging and computational modeling expose hidden features of calcium signaling route. A proper investigation of the role of calcium in specific senescence-associated routes and physiopathological conditions will expose forefront of calcium signaling and its association with cellular senescence.

Keywords: Wound pathophysiology; Ca^{2+} signaling; Cellular senescence; Healing; Regeneration

DESCRIPTION

The phenomenon of intercellular communication is a key feature of a cellular system in the pathophysiology conditions for the transfer of various messages. The pharmacological molecules influence the above-referred communication by hindering the release of some factors that play a part in these communications [1]. Senescent cells participate in many phenotypic alterations such as metabolic reprogramming, and autophagy modulation. Therefore, the senescent cells govern many physiological and pathological processes, as well as participate in anti-senescent therapies [2]. After wounding, epithelial cells communicate via cell-cell communication and coordinate with the migrant cells. Here, the injury-induced sustained Ca^{2+} travel between cells and generate communication within the wound edge and prevent further injuries and associated with changes in cell morphology (Figure 1). The role of skeletal muscle in regeneration is pivotal where interminably the muscle plasticity initiates the mechanism, thus, it is there as an essential element to regulate activities according to specific signaling mechanisms transpired within to govern various pathways and interrelated mechanisms [3]. By elucidating these signaling and other inter concerned, mechanisms, there is a possibility to find out the answer for the query, how calcium signaling regulates skeletal muscle development, homeostasis, and regeneration. Besides it, the calcium dynamics and calcium-dependent play a crucial role in these mechanisms [4]. It is a well-known fact that calcium governed myoblast proliferation and differentiation in growth. In an emergency, the injury-induced calcium signaling deals with originating harsh conditions. The most important phenomena of calcium signaling and cellular senescence ensued to initiate the satellite cells to participate in the aforementioned signaling pathways to inductee muscle regeneration [5]. It is a challenging task to decode these pathways in which the multiple spatial and temporal scales take part in all these signaling processes [6]. Here, the main component is the epithelial cells that can interpret these routes. The importance of calcium signaling is highlighted here because it regulates many featured activities in the cellular process, i.e., division, differentiation, migration, and death [7]. Therefore, the insights of these multiple signaling mechanisms that were transduced by calcium transients in the generation of epithelial tissues, are essential [8]. Using modern techniques, i.e., quantitative imaging and computational modeling, it is possible to expose different features of calcium signaling. These findings will boost the research efforts that are necessary for developing regenerative medicine. In wound repair, several cell signaling pathways are there to contribute and complete it, but calcium signaling predominantly participates in it [9]. The epidermal cell migration and regeneration patterns are there to follow until the final stage is not achieved. At this point, the author underlined the important role of calcium signaling and how it influenced cell migration, and remodeling, same is explained in this section in brief (Figure 2). Besides it, the other interrelated factors are not yet exposed nor investigated in detail [10]. But, it is clear from the discussion that the role of calcium and its management is important in healing of wounds.

Correspondence to: Rajiv Kumar, Department of Chemistry, National Institute of Medical Science, India, E-mail: chemistry_rajiv@hotmail.com

Received: April 23, 2021, **Accepted:** May 07, 2021, **Published:** May 15, 2021

Citation: Kumar R (2021) Wound Pathophysiology: Insights of Ca2+ Signaling and Cellular Senescence Mechanisms in Healing, and Regeneration. J Blood Disord Transfus. 12.463.

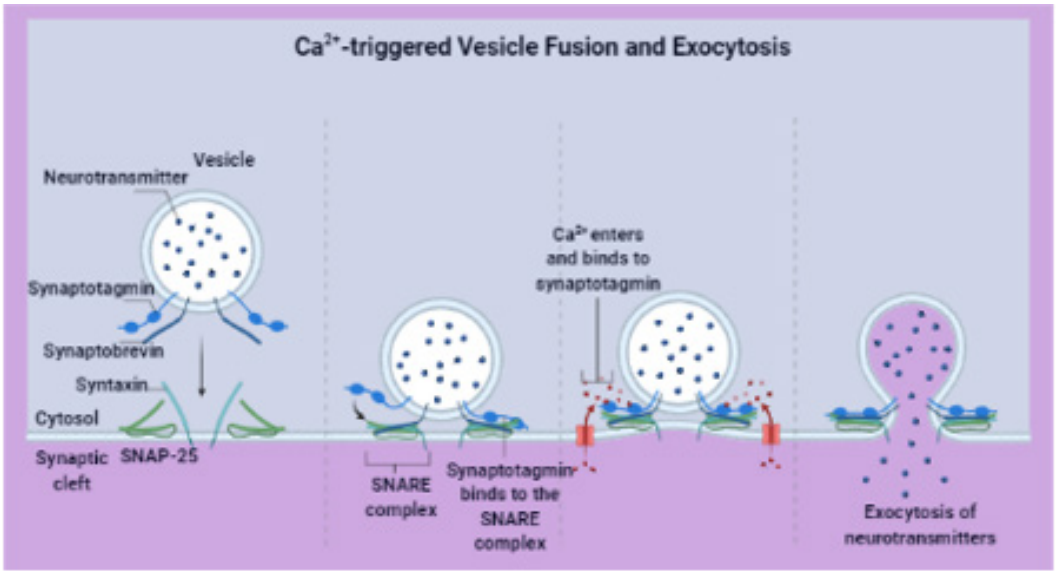

Figure 1: Illustrate the phenomenon of Ca2+ signaling in cellular events. "Adapted and created with permission from [biorender.com] and acknowledged.

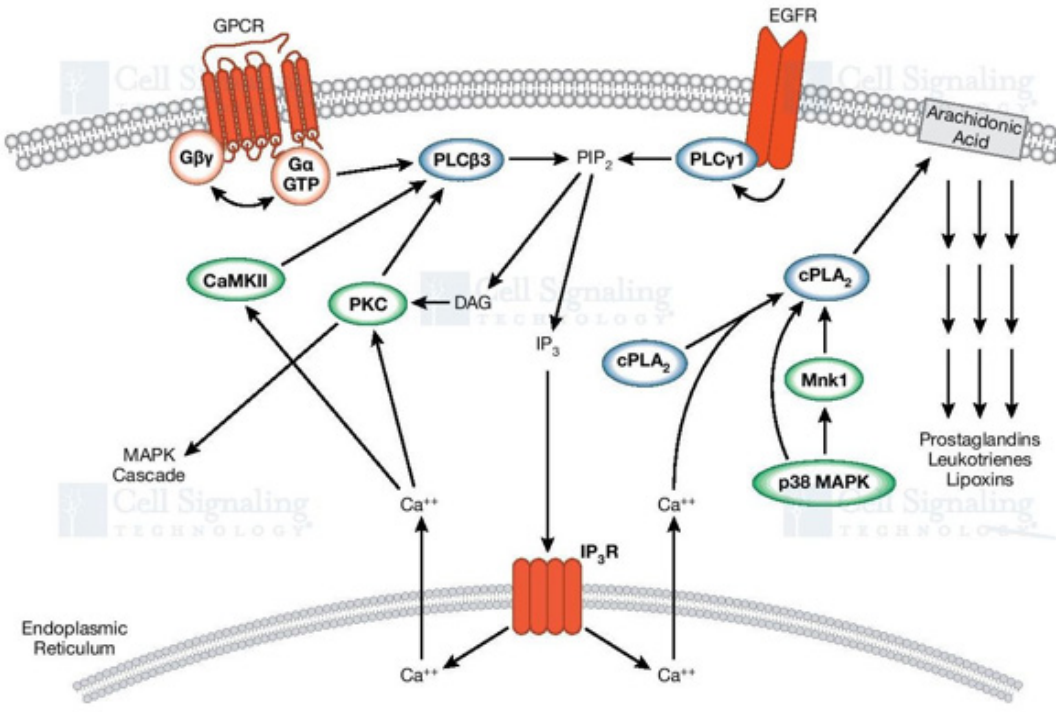

Figure 2: Calcium signaling and cellular senescence, receptor non receptor tyrosine kinases during activation. Members of the PLCβ subfamily are activated by α- or β/γ-subunits of proteins and play an important role in signaling cascades.

The role of the molecular and cellular mechanisms of cellular senescence is critical in calcium signaling and how it controlled it, explained by conducting extensive research that helped in detecting concerned pathways and routes [11]. Scientifically, it is proved that cellular senescence has a key involvement and is interlinked to age-related diseases. It has also been acted to stabilize the proliferation arrest tempted by many stresses [12]. Recently, it was reported that the calcium signaling participates in the form of a key promoter in all routes of cellular senescence, and it was also evidenced that the rise and fall in the concentration of intracellular calcium levels affected cellular senescence [13]. When any disease persists, to encounter it, the cells generate various movements on cellular environment for altering the local environment to remodel cellular metabolism [14]. Further, a decrease in mitochondrial Ca^{2+} uptake also affected metabolic remodeling, and alters gene expression associated with the processes of fibroblast and my fibroblast differentiation.

CONCLUSION

Damage-associated molecular patterns communicate among damaged cells/tissues and neighboring healthy cells. During these changes and computations, ATP receptors monitor damages activate a Ca^{2+} channel in the surrounding healthy cells, and propagate further according to the release and diffusion model that stop harmful inflammatory responses. Therefore, these findings will be helpful in the identification of specific features of cells in vivo to be considered during the planning of strategies for altering senescence features for therapeutic for healing chronic tissue senescence. Overall, the quickly tempted senescence is helpful for regeneration and acute wound repair. The author underlined the importance of planned strategies for managing senescence in chronic wounds and interrelated cutaneous pathologies depending on the physiological conditions.

ACKNOWLEDGMENT

The author (Rajiv Kumar) gratefully acknowledges his younger brother Bitto for motivation. The authors acknowledge bio render for providing the facility to illustrate the diagrams (Figure 1). The author acknowledges the support toward the reproduction of the illustrations (Figure 2) as a courtesy from Cell Signaling Technology, Inc. (www.cellsignal.com).

REFERENCES

1. Yang BA, Westerhof TM, Sabin K, Merajver SD, Aguilar CA. Engineered Tools to Study Intercellular Communication. John Wiley and Sons Inc. 2021; 8: 2002825.
2. Herranz N, Gil J. Mechanisms and Functions of Cellular Senescence. J Clin Invest. 2018; 128: 1238-1246.
3. Ma X, Warnier M, Raynard C, Ferrand M, Kirsh O, Defossez PA, et al. The Nuclear Receptor RXRA Controls Cellular Senescence by Regulating Calcium Signaling. Aging Cell. 2018; 6: 12831.
4. Kumar R, Gulia K. The convergence of nanotechnology-stem cell, nanotopography-mechanobiology, and biotic-abiotic interfaces: Nanoscale tools for tackling the top killer, arteriosclerosis, strokes, and heart attacks. Nano Sel. 2021; 2: 655–87.
5. Özsu N, Monteiro A. Wound healing, Calcium Signaling, and other Novel Pathways are Associated with the Formation of Butterfly Eyespots. BMC Genomics. 2017; 18: 788.
6. Wang Q, Symes AJ, Kane CA, Freeman A, Nariculam J, Munson P, et al. A novel role for Wnt/Ca^{2+} signaling in actin cytoskeleton remodeling and cell motility in prostate cancer. PLoS One. 2010.
7. Cann ML, Herring LE, Haar LL, Gilbert TSK, Goldfarb D, Richards KL, et al. Dasatinib Is Preferentially Active in the Activated B-Cell Subtype of Diffuse Large B-Cell Lymphoma. J Proteome Res. 2019; 18: 522-534.
8. Xue C. Repurposing dasatinib for ibrutinib-resistant diffuse large B-cell lymphoma. Blood. 2017; 20: 467.
9. Ghilardi SJ, O'Reilly BM, Sgro AE. Intracellular signaling dynamics and their role in coordinating tissue repair. Wiley Interdiscip Rev Syst Biol Med. 2020; 3: 1479.
10. Rojczyk-Gołębiewska E, Kucharzewski M, Wilemska-Kucharzewska K, Pałasz A. Calcium signaling in wound healing. Leczenie Ran. 2013.
11. Kumar R, Chhikara BS, Gulia K, Chhillar M. Review of nanotheranostics for molecular mechanisms underlying psychiatric disorders and commensurate nanotherapeutics for neuropsychiatry: The mind knockout. Nanotheranostics. 2021; 5: 288–308.
12. Oda Y, Tu CL, Menendez A, Nguyen T, Bikle DD. Vitamin D and calcium regulation of epidermal wound healing. J Steroid Biochem Mol Biol. 2016; 164: 379-385.
13. Wang S, Yang H, Tang Z, Long G, Huang W. Wound dressing model of human umbilical cord mesenchymal stem cells-alginates complex promotes skin wound healing by paracrine signaling. Stem Cells Int. 2016; 3269267.
14. Kumar R, Chhikara BS, Gulia K, Chhillar M. Cleaning the molecular machinery of cellsviaproteostasis, proteolysis and endocytosis selectively, effectively, and precisely: intracellular self-defense and cellular perturbations. Mol. Omics. 2021; 17: 11–28.