

Communication

Stress Riser in Orthopedics

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Abstract: For the adequate treatment of bone fractures, it is necessary to have knowledge about mechanical concepts as the interaction of implants and bone. The understanding of the concept of stress riser must be clear for surgeon for adequate surgical planning, thus preventing refracture due to incorrect application of implants. This article presents the concept of stress riser applied to orthopedics and briefly discussion.

Keywords: Bone; Fracture; Stress; Strain; Biomechanics

1. Communication

Any object applied of a certain load points are formed where the stress is significantly greater than elsewhere. This call a stress riser and occurred due to changes in its geometry. This behavior could be compared to the flow of water in a river. In the calm and flat part, the flow is uniform, but around a rock, tree branch or in a curve, the flow is intense due to the increase in speed and in pressure to overcome the obstacle. Likewise, parallel lines of stress in a structure are concentrated in the stress riser area [1,2].

In a structure, the change of shape induces a variation in the stress distribution. Stresses are also concentrated around discontinuities such as holes, sharp angles, notches, grooves, threads, and any other sudden transitions. These discontinuities are also known as stress risers and can weaken a structure [1,3,4] (Figure 1).

How to cite this paper:

Souza, A. F., & De Zoppa, A. L. do V. (2022). Stress Riser in Orthopedics. *Global Journal of Orthopedics*, 1(1), 8–10. Retrieved from <https://www.scipublications.com/journal/index.php/gjo/article/view/446>

Received: August 25, 2022

Accepted: October 2, 2022

Published: October 4, 2022



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Figure 1. A e B. Examples of cracks in sidewalks due to stress riser formation at corners (arrows).

A cylinder with a slot on one side (open section) is weaker if it did not have one, when it is applied to torsional loads. In an intact cylinder, all developed stresses resist the applied load, however in an open section, only a fraction do. If the stresses are represented as arrows resisting the applied load, the open section reverses its direction on the inner wall. The induced brittleness is independent of the defect width. The bone and metal are equally affected [1].

A fracture can start in a hole in the bone [5] or in a gap created by the removal of a cortical graft. Other clinical examples of stress-induced damage include pathologic fracture through a tumor, a re-fracture near an area of the callus, and a fracture at the end of a bone plate [1,2,6,7] (Figure 2).

The holes created and screws implanted in the bone constitute stress riser sites, which weaken and can lead to fracture and re-fracture with less load than that necessary for the fracture to occur in an intact bone [2,8,9]. It was noted that over a period of eight weeks, the stress riser produced by the presence of implants was no longer identified, and this was attributed to bone remodeling. When the screw is removed, however, the bone can again become brittle, because of microdamage produced by the screw removal. Although this effect has been demonstrated experimentally, there are few data on the time a bone is at risk when an implant is applied or removed [10].

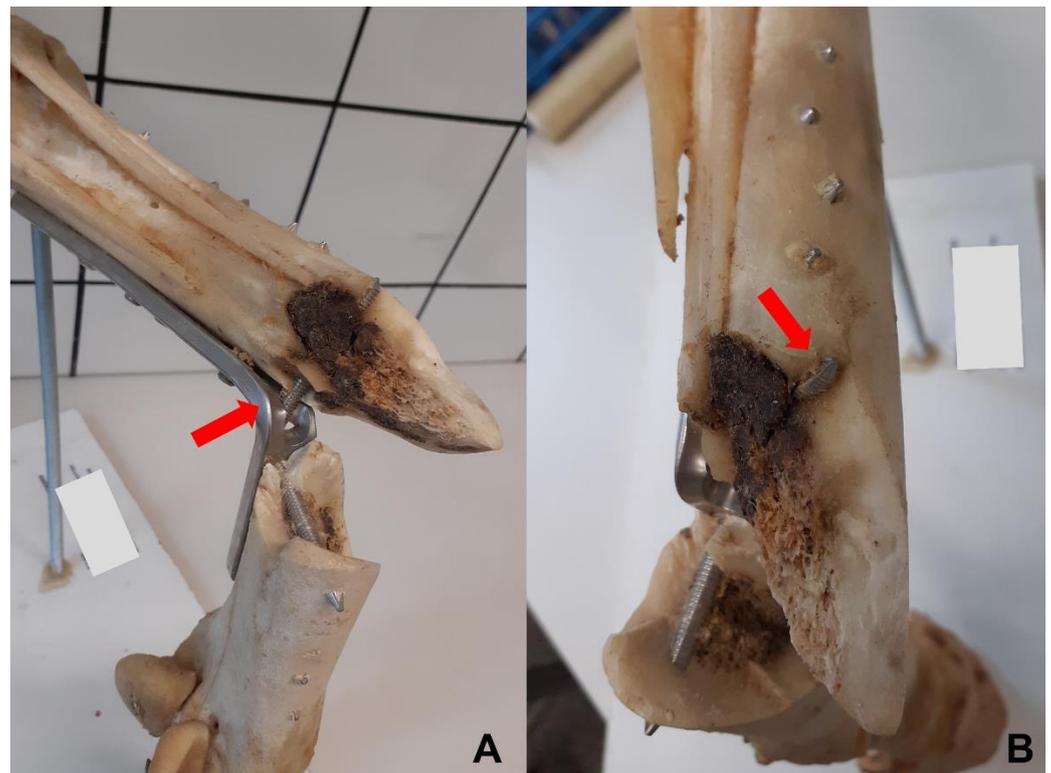


Figure 2. Refracture in the principal metatarsal bone of a horse that underwent osteosynthesis due to a spiral fracture of the medial condyle. Note that the plate bent at the interface between the part of the combined hole filled with a locking screw and its empty part (A). Fracture propagation occurred from the hole of one of the screws (B).

In clinical observations, fractures through screw holes were identified up to 11 months after implant removal and fractures up to two years after implant application [10]. The decision on how to approach fractures in athletes and the entire follow-up process to return to high performance activities still lacks more evidence, however, implant removal has been a recommended approach [11].

In summary, obtaining information about the occurrence, configuration, and approaches to minimize the consequences of stress riser in the fixation of bone fractures are important for increasingly efficient approaches to be made.

Author Contributions: Conceptualization, AFS; writing—original draft preparation, AFS; writing—review and editing, AFS and ALVZ. All authors have read and agreed to the published version of the manuscript.

Funding: Grant # 2021/07105-9, São Paulo Research Foundation (FAPESP).

Conflicts of Interest: The authors declare no conflict of interest.

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