# Healing Times for Circular Wounds on Plane and Spherical Bone Surfaces

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**Abstract:** A mathematical model is developed for the rate of healing of a circular wound in a spherical "skull". The motivation for this model is based on experimental studies of the "critical size defect" (CSD) in animal models; this has been defined as the smallest intraosseous wound that does not heal by bone formation during the lifetime of the animal [1]. For practical purposes this timescale can usually be taken as one year. In [2], the definition was further extended to a defect which has less than ten percent bony regeneration during the lifetime of the animal. CSD's can "heal" by fibrous connective tissue formation, but since this is not bone it does not have the properties (strength, etc.) that a completely healed defect would. Earlier models of bone wound healing (Adam [11], Arnold and Adam [12]) have focused on the existence (or not) of a CSD based on a steady-state analysis, so the time development of the wound was not addressed. In this paper the time development of a circular cylindrical wound is discussed from a general point of view. An integro-differential equation is derived for the radial contraction rate of the wound in terms of the wound radius and parameters related to the postulated healing mechanisms. This equation includes the effect of the curvature of the (spherical) skull, since it is clear from the experimental evidence that the size of the CSD increases monotonically with the size of the calvaria. Certain special cases for a planar wound are highlighted to illustrate the qualitative features of the model, in particular the dependence of the wound healing time on the initial wound size and the thickness of the healing rim.

Keywords: Wound healing, critical size defect, healing times, radial contraction