Clin Orthop Relat Res (2016) 474:836–837 / DOI 10.1007/s11999-015-4667-1

Clinical Orthopaedics and Related Research®
A Publication of The Association of Bone and Joint Surgeons®

Published online: 16 December 2015

CORR Insights

CORR Insights®: Gamma Radiation Sterilization Reduces the High-cycle Fatigue Life of Allograft Bone

Klaus Dieter Draenert MD

Where Are We Now?

Viral transmission from allograft tissue is rare, but when it occurs, it can be a life-threatening complication. Bacterial infections following allograft reconstructions are both common and limb-threatening. Minimizing the risks are crucial for patient safety. Therefore, any attention we can focus on graft sterilization is effort well spent. The sterilization process—cleaning, defatting, and storing the allograft—must be safe, efficient, and effective. Currently, sterilization generally uses ionizing radiation. Ethylene oxide and autoclave treatments are no longer used because of toxicity, loss of strength of the material, and loss of osteoinductive properties caused by the denaturation of proteins or the alkylation of amino acids [1, 2, 4–6]. Instead, the current standard is gamma-radiation sterilization because of its convenience and effectiveness both against bacterial contaminants as well as viral transmission (HIV and Hepatitis C). However, irradiation damages the collagenous fiber system by cracking the polymer chains and alkylation of free radicals. Crosslinking or free radical scavenging could reduce the damage caused by irradiation. Since both are achieved with chemical solutions, it is important to validate the penetration depth of the chemicals applied.

Where Do We Need To Go?

In order to achieve safe and efficient graft sterilization, we must combine different treatments. The combination of the safest chemical treatment with the lowest irradiation dose can balance the disadvantages of each of those two approaches. The collagenous fibers resist ice crystal damage, the ground substance, however, not, resulting in loss of tension of the fiber pattern. This is well known from electron microscopy and can be counteracted by antifreezing solutions like dimethylsulfoxide [3].

How Do We Get There?

Because most of the radioprotective treatments include chemical solutions, it is important to understand how fast and how deep the radioprotectives can penetrate mineralized bone. Scanning electron microscopy, in combination with a fatigue test, may yield valuable

This CORR Insights® *is a commentary on the article* "Gamma Radiation Sterilization Reduces the High-cycle Fatigue Life of Allograft Bone" *by Islam and colleagues available at:* DOI: 10.1007/s11999-015-4589-y.
The author certifies that he, or any member of his immediate family, has no funding or commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.
All ICMJE Conflict of Interest Forms for authors and *Clinical Orthopaedics and Related Research*® editors and board members are on file with the publication and can be viewed on request.
The opinions expressed are those of the writers, and do not reflect the opinion or policy of *CORR*® or The Association of Bone and Joint Surgeons®.
This *CORR* Insights® comment refers to the article available at DOI: 10.1007/s11999-015-4589-y.

K. D. Draenert MD (✉)
Center for Orthopaedic Sciences,
Gabriel-Max-Strasse 3, 81545 Munich, Bavaria, Germany
e-mail: k.draenert@zow.ch

CORR Insights

information regarding the integrity of collagenous fiber pattern.

Finally, mechanical strength should be compared across the various processing approaches, particularly focusing on fatigue strength, since that is the mode of failure of greatest clinical relevance.

References

1. Centers for Disease Control and Prevention (CDC). About tissue transplants. Available at http://www.cdc.gov/ncidod/dhqp/tissuetransplantsfaq.html. Accessed November 30, 2015.
2. Cheung DT, Perelman N, Tong D, Nimmi ME. The effect of gamma irradiation on collagen molecules, isolated alpha-chains, and crosslinked native fibers. *J Biomed Mater Res*. 1990;24:581–589.
3. Draenert Y, Draenert K. Ice crystal damage in freeze-dried articular cartilage studied by scanning electron microscopy. *Scan Electron Microsc*. 1982;(part 4):1799–1804.
4. Seto A, Gatt CJ Jr, Dunn MG. Improved tendon radioprotection by combining cross-linking and free radical scavenging. *Clin Orthop Rel Res*. 2009;467:2994–3001.
5. Seto A, Gatt CJ Jr, Dunn MG. Radioprotection of tendon tissue via cross-linking and free radical scavenging. *Clin Orthop Relat Res*. 2008;466:1788–1795.
6. Smith RA, Ingels J, Lochemes JJ, Dutkowsky JP, Pifer LL. Gamma irradiation of HIV-1. *J Orthop Res*. 2001;19:815–819.