PHYSICAL AND CHEMICAL CHARACTERISTICS OF HIGH-DOSE GAMMMA IRRADIATED SOCKETS -RITRIEVAL STUDY AFTER LONG TERM IMPLANTATION

+ Oonishi, H., Saito, M., ** Masuda, S., **Fujisawa, A., ***Kadoya, Y., ****Clarke, I.C., **** Kawanabe, K., .Artificial Joint Section and Biomaterial research lab. Osaka-Minami National Hospital, 2-1, Kido-Higashi machi , Kawachnagano City, Osaka 586-0000, Osaka, Japan.

INTRODUCTION

It is well known that the gamma irradiation result in oxidative degeneration of polyethylene (PE) which compromise the wear resistance. However, gamma irradiation induce crosslinking and potentially increases the wear resistance of PE. We found a significantly increased wear resistance of high-dose (100 Mrad) gamma irradiated PE (High Density Polyethylene; HDP) sockets in total hip replacement (THR)(1). The purpose of this study is to evaluate the physical, chemical and mechanical characteristics of this high dose irradiated PE sockets retrieved after 15 years after implantation .

MATERIALS AND METHODS

All materials examined were HDP (RCH 1000) as follows. Radiation was performed in the ambient air.

1. Two retrieved high-dose (100 Mrad) gamma irradiated HDP sockets retrieved at autopsy in 15 and 16 years after the implantation.
2. Two non-irradiated PE sockets retrieved at autopsy both in 15 years after the implantation.
3. Two high-dose (100 Mrad) gamma irradiated HDP sockets stocked on the shelf for 18 years.
4. Two non-irradiated HDP sockets stocked on the shelf for 18 years.

The test piece (n = 6 for each test) for mechanical property testing were sectioned from these sockets. Tensile strength/elongation, hardness and density were evaluated according to the Japanese Industrial Standard (JIS) K7133, ASTM D2240 and JIS K7202 respectively. The existence of oxidation (C = O) was examined with FTIR. Gel content was calculated from the weight of undissolved PE against orthodichlorobenzene to estimate the presence of crosslinking. Free radical was measured by electron spin resonance.

RESULTS

The results were expressed as a mean value of the two specimens and summarized in Table 1

Table 1

	1	2	3	4
Tensile strength (Mpa)	**36**	**40**	**32**	**26**
Elongation (%)	**87**	**212**	**110**	**120**
Hardness (HDD)	**65**	**63**	**65**	**67**
Density (g/ml)	**0.953**	**0.946**	**0.953**	**0.955**
Oxidation (%): outside	**0.5**	**0.6**	**0.6**	**0.6**
Oxidation (%): inside	**0.4**	**0.1**	**0.5**	**0.3**
Gel content (%)	**82**	**42**	**80**	**25**
Free radicals : outside	**1.7**	**0.2**	**0.8**	**0.4**
Free radicals : inside	**1.6**	**0.1**	**1.1**	**0.2**

1: Irradiated, retrieved. 2: Non-irradiated, retrieved
3: Irradiated. stored. 4: Non-irradiated, stored

DISCUSSION AND CONCLUSION

The overall results suggest that mechanical properties of high-dose gamma irradiated has not deteriorated during 15 to 16 years service in vivo.

Chemical property analysis demonstrated that Non-irradiated sockets undergone similar degree of surface oxidation as irradiated sockets. It is evident that free radicals were retained for long period of time both in vivo and in vitro and free radicals in PE seemed to be more stable in vivo than those kept unimplanted. The increment of oxidation in the body fluid was not observed compared to the ambient environment.

These data have demonstrated that high dose irradiated PE is highly stable and durable in human body and thus confirmed that this is promising articulating material in total joint replacement.

References

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Kyocera Co. Ltd. Kyoto, Japan. ***Dept. Orthopaedic surgery, Osaka City University Medical School, Osaka Japan. ** Dept. Orthopaedic Surgery, Loma Linda University School of Medicine, Loma Linda, CA, USA