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Title: Finite element analysis on longitudinal and radial functionally graded femoral prosthesis

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Abstract: This study focused on developing a 3D finite element model of functionally graded femoral prostheses to decrease stress shielding and to improve total hip replacement performance. The mechanical properties of the modeled functionally graded femoral prostheses were adjusted in the sagittal and transverse planes by changing the volume fraction gradient exponent. Prostheses with material changes in the sagittal and transverse planes were considered longitudinal and radial prostheses, respectively. The effects of cemented and noncemented implantation methods were also considered in this study. Strain energy and von Mises stresses were determined at the femoral proximal metaphysis and interfaces of the implanted femur components, respectively. Results demonstrated that the strain energy increased proportionally with increasing volume fraction gradient exponent, whereas the interface stresses decreased on the prostheses surfaces. A limited increase was also observed at the surfaces of the bone and cement. The periprosthetic femur with a noncemented prosthesis exhibited higher strain energy than with a cemented prosthesis. Radial prostheses implantation displayed more strain energy than longitudinal prostheses implantation in the femoral proximal part. Functionally graded materials also increased strain energy and exhibited promising potentials as substitutes of conventional materials to decrease stress shielding and to enhance total hip replacement lifespan. Copyright (c) 2013 John Wiley & Sons, Ltd.

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