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Design process of cementless femoral stem using a nonlinear three dimensional finite element analysis (Article)

Baharuddin, M.Y.[ab], Salleh, S.-H.[b], Zulkifly, A.H.[c], Lee, M.H.[d], Noor, A.M.[b], A Harris, A.R.[b], Majid, N.A.[b], Abd Kader, A.S.[e]

[a]Department of Biomedical Engineering, Faculty of Engineering, University of Malaya, Kuala Lumpur, Malaysia
[b]Centre for Biomedical Engineering Transportation Research Alliance, Universiti Teknologi Malaysia, Skudai, Johor, Malaysia
[c]Department of Orthopaedic, Traumatology and Rehabilitation, Kuliyyah of Medicine, International Islamic University Malaysia, Kuantan, Pahang, Malaysia

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Abstract

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Background: Minimal available information concerning hip morphology is the motivation for several researchers to study the difference between Asian and Western populations. Current use of a universal hip stem of variable size is not the best option for all femur types. This present study proposed a new design process of the cementless femoral stem using a three dimensional model which provided more information and accurate analysis compared to conventional methods. Methods. This complete design cycle began with morphological analysis, followed by femoral stem design, fit and fill analysis, and nonlinear finite element analysis (FEA). Various femur parameters for periosteal and endosteal canal diameters are measured from the osteotomy level to 150 mm below to determine the isthmus position. Results: The results showed better total fit (53.7%) and fill (76.7%) canal, with more load distributed proximally to prevent stress shielding at calcar region. The stem demonstrated lower displacement and micromotion (less than 40 μm) promoting osseointegration between the stem-bone and providing primary fixation stability. Conclusion: This new design process could be used as a preclinical assessment tool and will shorten the design cycle by identifying the major steps which must be taken while designing the femoral stem. © 2014 Baharuddin et al.; licensee BioMed Central Ltd.

Author keywords

Cementless hip | Femur | Finite element analysis | Hip replacement | Morphology

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