INTISARI

Femoral stem dengan bahan *titanium alloy* (Ti-6Al-4V) memiliki modulus elastisitas yang tinggi dibandingkan tulang manusia. Perbedaan modulus elastisitas antara *titanium alloy* dengan tulang menyebabkan stress shielding yang dapat mengakibatkan penurunan massa tulang dan komplikasi serius seperti fraktur periprostetik. Penelitian ini membahas penggunaan struktur *lattice triply periodic minimal surface* (TPMS) pada *femoral stem* untuk mengurangi risiko *stress shielding* tanpa mengurangi tingkat keamanan dari produk *femoral stem.* Terdapat total 10 model *femoral stem*, yaitu *solid femoral stem, Gyroid* porositas 30%, *Gyroid* porositas 40%, *Gyroid* porositas 50%, *Schwarz-P* porositas 30%, *Schwarz-P* porositas 40%, *Schwarz-P* porositas 50%, *Schwarz-D* porositas 30%, *Schwarz-D* porositas 40%, dan *Schwarz-D* porositas 50%. Masing-masing model *femoral stem* dilakukan uji simulasi *finite element* dengan memberikan tiga kondisi pembebanan yang berbeda, yaitu *hip contact,* berjalan, dan menaiki tangga. Berdasarkan nilai *von Mises stress* yang didapatkan, dilakukan perhitungan *stress-shielding increase* (SSI). Hasil perhitungan SSI menunjukkan bahwa semakin besar porositas *lattice*, semakin rendah nilai SSI yang dihasilkan. Semakin rendah nilai SSI, maka resiko komplikasi *stress-shielding* yang menyebabkan fraktur tulang dapat ditekan.

Kata kunci: *titanium alloy, femoral stem,* TPMS, *finite element,* posositas

ABSTRACT

Femoral stem made from titanium alloy (Ti-6Al-4V) has a high elastic modulus compared to human bone, causing stress shielding which can result in bone mass reduction and serious complications such as periprosthetic fractures. This study discusses the use of a triply periodic minimal surface (TPMS) lattice structure on the femoral stem to reduce the risk of stress shielding without compromising the safety of the femoral stem product. There are a total of 10 femoral stem models, namely solid femoral stem, Gyroid with 30% porosity, Gyroid with 40% porosity, Gyroid with 50% porosity, Schwarz-P with 30% porosity, Schwarz-P with 40% porosity, Schwarz-P with 50% porosity, Schwarz-D with 30% porosity, Schwarz-D with 40% porosity, and Schwarz-D with 50% porosity. Each femoral stem model underwent finite element simulation testing under three different loading conditions: hip contact, walking, and climbing. Based on the obtained von Mises stress values, the stress-shielding increase (SSI) was calculated. The SSI calculation results show that the greater the lattice porosity, the lower the resulting SSI value. The lower the SSI value, the lower the risk of stress-shielding complications that cause bone fractures.

Keywords: titanium alloy, femoral stem, TPMS, finite element, porosity