Kekuatan Fiksasi Screw Pada Konstruksi Acetabuloplasty Dengan Containment Defect 30%: Sebuah Uji Biomekanik Pada Tulang Sintetis = Screw Fixation Strength In Acetabuloplasty Constructs With 30% Containment Defect: A Biomechanical Test On Synthetic Bone

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Abstrak

Latar Belakang: Acetabuloplasty dengan bone graft merupakan salah satu tatalaksana adult congenital hip disease. Tindakan ini bertujuan memperbaiki defisiensi dinding acetabulum dan meningkatkan stabilitas implant. Namun, terdapat variasi dalam teknik, lokasi, dan jenis implant yang dapat dipasang. Oleh karena itu, penelitian ini bertujuan membandingkan kekuatan konstruksi acetabuloplasty dengan pelbagai screw pada teknik bone graft kepala femur. Metode: Model pelvis 3D dibuat dengan simulasi defek containment 30% pada sisi antero-superior acetabulum. Rekonstruksi acetabuloplasty dibuat tulang kepala femur berbentuk angka 7 difiksasi dengan screw, diikuti uji finite element untuk menilai distribusi stres. Konstruk acetabuloplasty diaplikasikan pada tiga kelompok uji: A (2 screw cannulated ukuran 6.5 mm), B (2 screw cortical ukuran 4.5 mm), C (1 screw cannulated 6.5 mm + 1 screw cortical 4.5 mm). Spesimen diberi beban dari 50 hingga 750 N dengan peningkatan sebesar 100 N/detik sebagai simulasi single leg stance. FGM pada beban 750 N diukur menggunakan kamera. Kemudian dilakukan uji load to failure. Hasil: Kelompok sampel cannulated ukuran 6.5 mm lebih unggul secara significant pada uji load to failure dengan titik patah 2 kali lipat lebih besar dibandingkan kelompok lainnya (2191 N v 1206 N v 1065 N; $p<0.01$). Uji loading dengan 750 Newton juga menunjukkan bahwa kelompok A unggul dengan rerata pergeseran, peregangan, dan tilting terkecil di semua posisi marking kecuali pada tilting marking posterior superior. Sampel cannulated ukuran 6.5mm juga memiliki titik yield dan titik kekuatan maksimum terbesar. Sementara itu, kelompok B dan C memiliki hasil uji yang serupa satu sama lain. Tetapi, temuan ini tidak bermakna secara statistik ($p>0.05$) Kesimpulan: Acetabuloplasty dengan bone graft adalah metode biomekanik yang aman untuk terapi definitif pada congenital adult hip disease. Pemilihan screw cannulated dengan ukuran diameter screw lebih besar memiliki keunggulan biomekanik bila dibandingkan dengan kelompok uji screw cortical maupun kombinasi antara kedua screw.

.....Background: Acetabuloplasty using bone grafts is one of the treatment options for adult congenital hip disease. It aims to correct acetabular wall deficiencies and enhance pelvic implant stability. However, there are variations in the positions, types, and techniques of screw placements, leaving the fixation strength unknown. Therefore, this study aims to evaluate the structural strength of acetabuloplasty with screws in femoral head bone graft techniques. Methods: A 3D pelvis model was created to simulate a 30% containment defect on the antero-superior aspect of the acetabulum. Acetabuloplasty reconstruction utilized a femoral head bone graft shaped like a "7," which was fixed with screws, followed by finite element analysis to assess stress distribution. The acetabuloplasty construct was applied to three test groups: A (2 cannulated screws - 6.5 mm), B (2 cortical screws - 4.5 mm), and C (1 cannulated screw - 6.5 mm + 1 non-cannulated screw - 4.5 mm). Specimens were subjected to loads ranging from 50 to 750 N, with increments of 100 N/sec to simulate single-leg stance. FGM at 750 N were measured using a camera. Then the specimens were subjected to loading until implant failure. Results: Group A with cannulated 6.5 mm screws

are shown to be significantly better in the load-to-failure test with a mean breaking point twice larger than the other two groups (2191 N v 1206 N v 1065 N; $p<0.01$). Group A also shows superior results in the single- leg stance in all marking positions with the smallest displacement, stretch, and tilting -bar the posterior superior tilt. Group A also has the largest yield and maximum strength point. In comparison, groups B and C had similarly inferior results. However, the findings are statistically insignificant ($p>0.05$). Conclusion: Acetabuloplasty with bone graft is a biomechanically safe method for definitive treatment of adult congenital hip disease. Larger cannulated screws are shown to have a biomechanical advantage compared to cortical smaller screws or a combination of both screws.