Luaran Klinis (Clinical Outcomes) Pada Pasien Dengan Gangguan Vertebral Pasca Intervensi Robotik: Studi Kohort Di RS X - Tangerang Selatan

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Abstrak

Latar Belakang: Perkembangan teknologi robotik dalam bedah tulang belakang menawarkan potensi peningkatan presisi, keselamatan, dan mutu pelayanan klinis. Namun, bukti empiris mengenai keunggulan teknik robotik dibandingkan teknik non-robotik masih menunjukkan hasil yang bervariasi, khususnya pada aspek luaran klinis dan efisiensi operasional. Di Indonesia, data komparatif yang terintegrasi dalam kerangka clinical governance masih terbatas. Metodologi: Penelitian ini menggunakan desain kohort retrospektif dengan data sekunder pasien bedah tulang belakang di Rumah Sakit X di wilayah Tangerang Selatan, periode November 2021–Maret 2026. Variabel luaran meliputi durasi operasi, perdarahan intra dan pascaoperasi, paparan radiasi, fungsi gerak, nyeri, dan lama rawat inap. Analisis dilakukan secara bertahap melalui analisis deskriptif, bivariat untuk membandingkan luaran antar kelompok, dan multivariat menggunakan regresi linear dengan robust standard error untuk penyesuaian faktor confounder (usia, jenis kelamin, indeks massa tubuh, status ASA (American Society of Anesthesiologists), dan jenis tindakan). Hasil: Sebanyak 89 pasien dianalisis (robotik = 55; non-robotik = 34). Tidak ditemukan komplikasi mayor maupun variasi akurasi penempatan sekrup pada kedua kelompok. Analisis bivariat menunjukkan bahwa teknik robotik memiliki durasi operasi yang lebih lama dibandingkan teknik non-robotik (p < 0,05), namun menunjukkan keunggulan dalam menurunkan paparan radiasi dan perdarahan pascaoperasi (p < 0,05). Tidak terdapat perbedaan bermakna pada perdarahan intraoperasi, fungsi gerak, nyeri, maupun lama rawat inap (p > 0,05). Hasil analisis multivariat menunjukkan bahwa faktor confounder tidak berpengaruh signifikan terhadap hubungan antara teknik operasi dan luaran klinis. Kesimpulan: Teknik robotik menunjukkan keunggulan selektif pada aspek keselamatan, khususnya dalam pengendalian paparan radiasi dan perdarahan pascaoperasi, namun tidak memberikan peningkatan yang konsisten pada seluruh luaran klinis dibandingkan teknik non-robotik. Oleh karena itu, evaluasi penggunaannya perlu dilakukan secara multidimensional dalam kerangka clinical governance, mencakup efektivitas, keselamatan, dan efisiensi. Rekomendasi: Diperlukan integrasi pencatatan data klinis dan paparan radiasi secara real-time dalam Electronic Medical Record (EMR) untuk mendukung monitoring dan evaluasi berbasis data. Implementasi clinical pathway berbasis luaran klinis serta standardisasi indikator keselamatan, termasuk prinsip ALARA, perlu diperkuat. Penelitian lanjutan dengan desain prospektif multicenter, penggunaan Patient-Reported Outcome Measures (PROMs), dan analisis cost-effectiveness direkomendasikan untuk menilai nilai tambah teknologi robotik secara komprehensif. <hr /> Background: Advances in robotic technology in spine surgery offer the potential to improve precision, patient safety, and overall quality of care. However, empirical evidence comparing robotic-assisted and non-robotic techniques remains inconsistent, particularly regarding clinical outcomes and operational efficiency. In Indonesia, integrated comparative data within a clinical governance framework are still limited. Methods: A retrospective cohort study was conducted using secondary data from patients who underwent spine surgery at South Tangerang Private Hospital, between November 2021 and

March 2026. Outcome variables included operative duration, intraoperative and postoperative blood loss, radiation exposure, functional mobility, pain scores, and length of hospital stay. Data were analyzed sequentially using descriptive analysis, bivariate analysis to assess differences between groups, and multivariable regression with robust standard errors to control for confounder factors (age, sex, body mass index, ASA (American Society of Anesthesiologists) status, and type of procedure). Results: A total of 89 patients were included (robotic-assisted = 55; non-robotic = 34). No major complications or variation in pedicle screw placement accuracy were observed in either group. Bivariate analysis showed that robotic-assisted surgery was associated with significantly longer operative duration (p < 0.05), but demonstrated advantages in reducing radiation exposure and postoperative blood loss (p < 0.05). No significant differences were found in intraoperative blood loss, functional outcomes, pain scores, or length of hospital stay (p > 0.05). Multivariable analysis indicated that confounder factors did not significantly affect the relationship between surgical technique and clinical outcomes. Conclusions: Robotic-assisted techniques demonstrate selective advantages in safety aspects, particularly in reducing radiation exposure and postoperative bleeding; however, they do not consistently improve overall clinical outcomes compared with non-robotic techniques. Therefore, their evaluation should be conducted within a multidimensional clinical governance framework, encompassing clinical effectiveness, safety, and operational efficiency. Recommendations: Integration of real-time clinical and radiation data recording into Electronic Medical Records (EMR) is essential to support safety monitoring and data-driven evaluation. Strengthening outcome-based clinical pathways and standardizing safety indicators, including adherence to the ALARA principle, should be consistently implemented. Furthermore, future studies employing prospective multicenter designs, incorporating Patient-Reported Outcome Measures (PROMs), and conducting cost-effectiveness analyses are recommended to comprehensively assess the added value of robotic technology in healthcare delivery.