Systematic Review And Meta-analysis Of Practical Simulators And Experimental Models For Supermicrosurgery

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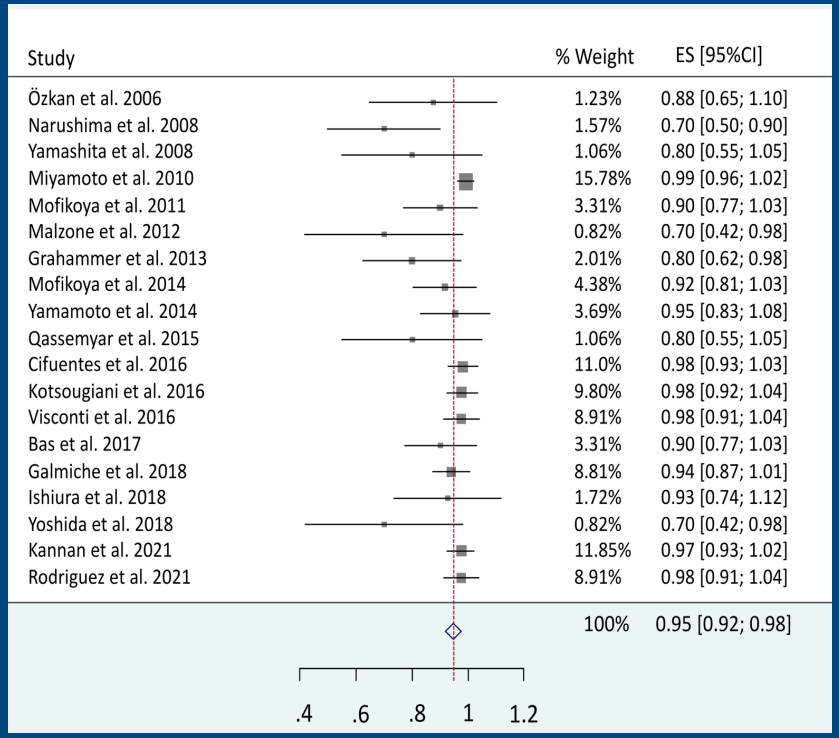
PURPOSE: Although most of the microsurgical concepts and principles rest within the scientific literature and intraoperative tutoring, the utmost constituent of a successful micro-anastomosis is a flawless technique learnt through hands-on training. This is especially true in supermicrosurgery, in which conventional microinstruments cannot be used to prevent backwall catching and fine movements are guided based on the sensation of the needle tip. Thus, we aimed to present a systematic review and meta-analysis of preclinical experimental models and simulation platforms used for supermicrosurgery.

METHODS: An electronic search was conducted across PubMed MEDLINE, Embase, Web of Science, and Scopus in accordance with the PRISMA statement. Data collection included the types of experimental models and outcomes. Validation was evaluated using the definitions by Crouch et al.1 For the meta-analysis, we calculated the prevalence of a patent anastomosis at the end of the observation period. Pooled estimates were calculated with a random-effect meta-analysis using the DerSimonian-Laird model.



RESULTS: Thirty-eight articles were incorporated in the qualitative synthesis. Twenty-three articles reported the use of in vivo models (60.5%), twelve used ex vivo models (31.5%), and three used synthetic models (7.9%). The superficial inferior epigastric system of rats was the most common in vivo model, while the chicken wings and hindlimbs were the most common methods used in ex vivo models. The most common methods to evaluate patency of anastomoses were gross inspection (n=11), the passage of a nylon thread through the lumen (n=5), and intravascular flow of an injected dye (n=8). Studies implementing free flaps as supermicrosurgical models had moderate predictive validity, while the fidelity of ex vivo models offered basic perforator flap harvest technique. Non-biologic models had adequate transfer validity. Nineteen studies reporting quantitative outcomes regarding the rate of a successful anastomosis were incorporated in the meta-analysis. The overall patency rate of anastomoses was 94.9% (95%CI 92.3% to 97.5%). The rate of a successful anastomosis of in vivo models using rats was 92.5% (95%CI 88.8% to 96.3%). The rate of a successful anastomosis of ex vivo models was 97.7% (95%CI 94.6% to >99%).

CONCLUSION: Simulators that have a high fidelity concerning the dissection of the vascular pedicles, flap elevation, supermicrovascular anastomosis, and adequate assessment of the patency of the anastomosis possess adequate predictive validation and grant microsurgeons with the highest possible expertise and skills before performing supermicrosurgery in the clinical setting. The included models must be regarded as mutually inclusive platforms in which basic supermicrosurgical skills can be developed using synthetic models due to their transfer validity, while ex vivo and in vivo biologic models are practical to refine supermicrosurgical techniques due to their predictive validity.