

Studi Eksperimental Injeksi Lokal Sel Punca Mesenkimal Tali Pusat Xenogenik pada Tukak Tekanan Derajat Tiga: Kajian terhadap Patomekanisme Regenerasi Jaringan = Experimental Study of Local Injection of Xenogenic Umbilical Cord Mesenchymal Stem Cells in Third-Degree Pressure Ulcers: A Study on the Pathomechanism of Tissue Regeneration

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Abstrak

Terapi sel punca kini menjadi salah satu pilihan menjanjikan dalam penatalaksanaan luka kronik, termasuk tukak tekanan. Studi eksperimental ini bertujuan mengevaluasi proses penyembuhan tukak tekanan derajat tiga melalui analisis kadar VEGFA untuk menilai kemampuan angiogenesis, deposisi kolagen dan fibronectin, penilaian parameter penyembuhan luka dengan skoring histologi, kemampuan epitelisasi, serta kekuatan tarik luka setelah injeksi sel punca mesenkimal dari tali pusat (SPM-TP).

Sebanyak 35 ekor tikus jantan Sprague-Dawley berusia usia 12 bulan dengan berat 300–350 g dibagi menjadi lima kelompok, yaitu kontrol biopsi, intervensi biopsi, kontrol regangan, intervensi regangan, dan regangan normal. Model tukak tekanan derajat tiga pada tikus diinduksi menggunakan magnet sirkular berkekuatan 1100–1350 G melalui tiga siklus iskemia-reperfusi. Kelompok intervensi menerima injeksi SPM-TP sebanyak 4 x 10 sel per ekor. Punch biopsy dilakukan pada hari ke-0, 3, 7, 14, dan 21. Sampel selanjutnya diolah menjadi blok parafin dan diberi pewarnaan hematoksilin dan eosin untuk skoring histologi, Masson's Trichrome untuk penilaian deposisi kolagen, dan antibodi anti-fibronectin untuk penilaian deposisi fibronectin. Ekstraksi RNA total juga dilakukan untuk mendeteksi mRNA VEGFA melalui RT-PCR. Evaluasi kekuatan tarik selanjutnya dilakukan pada akhir penelitian dengan Universal Testing System (Instron 5944) setelah prosedur eutanasia. Perkembangan luka kemudian didokumentasikan dan dianalisis untuk melihat luas area epitel dan eskar.

Hasil menunjukkan bahwa SPM-TP dapat memicu akselerasi penyembuhan luka sejak awal injeksi hingga hari ke-7 dan 14. Hal ini ditunjukkan dengan kadar VEGFA yang lebih rendah pada kelompok intervensi, peningkatan deposisi kolagen dan fibronectin, penyembuhan luka secara mikroskopis yang lebih cepat, serta sifat mekanik jaringan yang lebih menyerupai kulit normal dibanding kelompok kontrol. Temuan ini mengindikasikan perlunya injeksi SPM-TP dalam beberapa frekuensi pada periode tersebut guna mendukung penyembuhan optimal. Terapi ini berpotensi menjadi alternatif baru yang efisien dalam penanganan tukak tekanan.

.....Stem cell therapy has emerged as one of the promising options in managing chronic wounds, including pressure ulcers. This experimental study aimed to evaluate the healing process of pressure ulcers grade three by analyzing VEGFA levels to assess angiogenesis, collagen and fibronectin deposition, wound healing parameters through histological scoring, epithelialization capability, and tensile strength after umbilical cord-derived mesenchymal stem cell (UC-MSC) injections.

A total of 35 male Sprague-Dawley rats, which were 12 months old and weigh 300–350 g, were divided into five groups which were biopsy control, biopsy intervention, tension control, tension intervention, and normal tension. The pressure ulcers grade three were induced using circular magnets with a strength of 1100–1350 G through three cycles of ischemia-reperfusion. The intervention groups received UC-MSCs injections at a dose of 4×10^6 cells per rat. Punch biopsies were performed on days 0, 3, 7, 14, and 21. The tissue samples were processed into paraffin blocks and stained with hematoxylin and eosin (HE) for histological scoring, Masson's Trichrome for collagen deposition, and anti-fibronectin antibodies for fibronectin deposition. Total RNA was also extracted to detect VEGFA mRNA via RT-PCR. Tensile strength was evaluated at the end of the study using the Universal Testing System (Instron 5944) following euthanasia. Wound progression was documented and analyzed to measure the epithelium and eschar area.

The results showed that UC-MSCs were able to accelerate wound healing from the initial injection up to days 7 and 14. This was demonstrated by lower VEGFA levels in the intervention group, increased collagen and fibronectin deposition, faster microscopic wound healing, and tissue mechanical properties more closely resembling normal skin compared to the control group. These findings suggest the potential need for UC-MSCs injections at certain frequencies during this period to support optimal healing. This therapy has the potential to be an efficient alternative in the treatment of pressure ulcers.