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Changes in Cardiovascular Parameters during Hemodialysis, and Relation to Access Flow

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Background: Cardiovascular disease is the leading cause of morbidity and mortality in hemodialysis (HD) patients. Since cardiovascular parameters can change rapidly during dialysis, cardiac measurements are needed during a dialysis session to assess a patient's clinical condition and to make changes in dialysis prescription. The aim of this study was to assess the relationship between access flow and changes in cardiovascular parameters during dialysis.

Methods: Fifty nine hemodialysis patients whose mean access flow of the past 3 consecutive months was more than 1 L/min were included. Those with inadequately mature arteriovenous fistula (AVF) to sustain a blood flow of 250 ml/min, and those under current investigation for possible stenosis were excluded. Access flow (Qa), Qa/CO ratio (cardio-pulmonary recirculation, CPR), cardiac output (CO), cardiac index (CI), central blood volume index (CBVI), and peripheral vascular resistance (PVR) were measured by the ultrasound saline dilution method at 30 minutes, 2 hours, and 4 hours after the start of dialysis. Patients were surveyed for morbid symptoms such as dyspnea, palpitation, chest pain, edema, dizziness and muscle cramping, before, during and after dialysis.

Results: Fifty-three (89.8%) of the accesses were AVFs (24 radiocephalic, 21 brachiocephalic, 8 transposed brachiobasilic) and 6(10.2%) were arteriovenous grafts (3 forearm loop grafts, 3 upper arm straight grafts). At the start of HD, Qa ranged 0.8-4 L/min, CPR 9-64%, CO 3.1-11.1 L/min, CI 2.0-7.5 L/min/m^2, CBVI 11.0-37.5 ml/kg and PVR 9.0-27.6 mmHg/L/min. During 4 hours of HD, mean changes in CO, CI, CBVI, and PVR were -9.8%, -7.3%, -8.3%, and 17.6%, respectively. In comparison of the patients according to drop in CI during HD, ≥20% vs. <20%, the group with ≥20% drop in CI showed a significantly higher drop in mean arterial pressure (MAP) (-5.0 ± 10.6%) compared to the group with less than 20% drop in CI (2.1 ± 13.6%, P=0.021). The high CI drop group also showed higher drop in CBVI (-35.8 ± 22.3% vs. -3.3 ± 15.7%, P=0.000) and larger increase in PVR (27.1 ± 12.1% vs. 1.7 ± 25.1%, P=0.000). In comparison of the patients according to CPR, ≥30% vs. <30%, the group with ≥30% of CPR tended to have lower CI than the group with <30% of CPR (3.4 ± 0.8 vs. 3.8 ± 1.1 L/min/m^2, respectively). The high CPR group showed a significantly higher percentage of patients with morbid symptoms pre- and post-dialysis (*P*=0.018 and 0.037 respectively).

Conclusion: Our cross-sectional study shows that cardiovascular parameters change rapidly during HD, and the changes are associated with access flow, systemic hemodynamics, and symptoms related to cardiovascular

strain. Measurement of cardiovascular parameters during HD is recommended to screen high access flow-associated cardiovascular disease, and to correct dialysis prescription based on the changes in volume status during HD. A larger prospective study is needed to further define these findings.

Keywords: access flow, cardiac output, Hemodialysis