Minimal shedding of endothelial glycocalyx after fluid load during general anesthesia

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Background

The glycocalyx is a thin layer of membrane-bound proteoglycans and glycoproteins, covering the endothelium from the luminal side. It is negatively charged and form a network in which soluble molecules are incorporated. This fine layer has many functions, also determines vascular permeability to plasma proteins. Removal of any of its constituents dramatically affects glycocalyx properties leading to tissue edema formation [1]. Hypervolaemia caused by liberal fluid administration can lead to glycocalyx damage through release of natriuretic peptides from heart (2).

Objectives

Detect the fluid kinetics after massive fluid load and damage of endovascular glycocalyx layer during general anesthesia

Material and methods

The plasma and urine concentrations of three biomarkers of glycocalyx shedding (syndecan-1, hyaluronic acid and heparan sulfate) and plasma concentration of B type natriuretic peptide (BNP) were measured in patients before, during, and after elective open hysterectomy. The intervention fluid therapy consisted of 25 ml/kg of Ringer’s lactate infused over 30 min started right after the induction of anesthesia. The resulting plasma volume expansion was estimated from the haemodilution. Inclusion criteria were ages between 25 and 55 years, no chronic cardiopulmonary or renal diseases and expected blood loss <500 ml. Blood samples were taken after general anesthesia had been induced, but just before the fluid load was initiated, and then 30, 60, and 90 min later. A final sample was taken 2 h after the anesthesia had been terminated. Urine was collected from the catheter output on the same occasions as the blood samples were taken.

Results

Mean volume of Ringer’s lactate infused reached 1964±387 ml. Systolic and diastolic arterial pressure decreased during anesthesia (Table 1 and 2). Despite the plasma volume expansion by 37±6% there was no significant change in BNP concentration before, during and after surgery (25.1 pg/ml and 22.7 pg/ml). The plasma concentrations of syndecan-1 also were unchanged during anesthesia, surgery, and postoperative care (21.0 vs 19.7 ng/ml respectively). The hyaluronic acid concentrations decreased (from 38.0 to 27.7 ng/ml) while those of heparan sulfate slightly increased (from 3.4 to 5.5 µg/ml).

Conclusions

No clear evidence was found for shedding of the glycocalyx layer during an abdominal hysterectomy after a rapid infusion of 25 ml/kg of Ringer’s lactate.

Table 1. Main patient’s characteristics (n=7)

Age (years)	49 ± 4.6
Weight (kg)	76 ± 13.7
Volume infused (ml)	1964 ± 387
Blood loss (ml)	164 ± 48

Table 2. Changes in haemodynamics and concentration of glycocalyx shedding products during surgery

	Baseline	Surgery	P value
Haemodynamics			
Systolic BP (mmHg)	144 ± 22	112 ± 11	P<0.02
Diastolic BP (mmHg)	84 ± 15	68 ± 7	NS
Shedding products in plasma			
Syndecan-1 (ng/ml)	21.0 ± 3.6	19.7 ± 5.1	NS
Hyaluronic acid (ng/ml)	38.0 ± 6.9	27.7 ± 5.3	p<0.03
Heparan sulfate (µg/ml)	3.4 ± 0.9	5.5 ± 0.8	p<0.001

Fig. 1 The concentrations of three shedding products of the endothelial glycocalyx layer.

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2. Curry FR: Atrial natriuretic peptide: an essential physiological regulator of transvascular fluid, protein transport, and plasma volume. J Clin Invest. 2005, 115: 1458-1461.