Vasomotor function in rat arteries after ex vivo and intragastric exposure to food-grade titanium dioxide and vegetable carbon particles

Background: Humans are continuously exposed to particles in the gastrointestinal tract. Exposure may occur directly through ingestion of particles via food or indirectly by removal of inhaled material from the airways by the mucociliary clearance system. We examined the effects of food-grade particle exposure on vasomotor function and systemic oxidative stress in an ex vivo study and intragastrically exposed rats.

Methods: In an ex vivo study, aorta rings from naive Sprague-Dawley rats were exposed for 30 min to food-grade TiO$_2$ (E171), benchmark TiO$_2$ (Aeroxide P25), food-grade vegetable carbon (E153) or benchmark carbon black (Printex 90). Subsequently, the vasomotor function was assessed in wire myographs. In an in vivo study, lean Zucker rats were exposed intragastrically once a week for 10 weeks to vehicle, E171 or E153. Doses were comparable to human daily intake. Vasomotor function in the coronary arteries and aorta was assessed using wire myographs. Tetrahydrobiopterin, ascorbate, malondialdehyde and asymmetric dimethylarginine were measured in blood as markers of oxidative stress and vascular function.

Results: Direct exposure of E171 to aorta rings ex vivo increased the acetylcholine-induced vasorelaxation and 5-hydroxytryptamine-induced vasocontraction. E153 only increased acetylcholine-induced vasorelaxation, and Printex 90 increased the 5-hydroxytryptamine-induced vasocontraction, whereas Aeroxide P25 did not affect the vasomotor function. In vivo exposure showed similar results as ex vivo exposure; increased acetylcholine-induced vasorelaxation in coronary artery segments of E153 and E171 exposed rats, whereas E171 exposure altered 5-hydroxytryptamine-induced vasoconstriction in distal coronary artery segments.

Plasma levels of markers of oxidative stress and vascular function showed no differences between groups.

Conclusion: Gastrointestinal tract exposure to E171 and E153 was associated with modest albeit statistically significant alterations in the vasoconstriction and vasorelaxation responses. Direct particle exposure to aorta rings elicited a similar type of response. The vasomotor responses were not related to biomarkers of systemic oxidative stress.