Stingray™ Circle Absorber

Universal Low-Flow Anesthesia System for Animals 5lb to 175lb

Over 80% of anaesthetised animals are smaller than 35lb and traditionally a variety of non-rebreathing circuits have been used, particularly for animals below 20lb. Resistance, dead space, rebreathing of CO₂, slow response and unpredictable inhalation anesthetic concentrations are all suggested as reasons for not using circle systems. However non-rebreathing systems require high flows (up to 20 x that of efficient circle systems) of cold gas which contributes to hypothermia, cost and increases environmental WAG pollution.

Design, sizing and placement of components including valves, hoses and connecting passages can affect resistance, circuit volume and speed of response to changes in delivered inhalation anesthetic. A novel circle breathing system, the Darvall Stingray™ has been developed with the goal of overcoming the limitations of using circle systems in animals as small as 5lb. This circle system was tested for resistance and rate of change of anesthetic concentration against other commonly used circle systems.1,3

Resistance to gas flow

In this study we compared resistance of the Darvall Stingray™, designed to minimize resistance and maximize speed of response, against some commonly available CBS’s used in veterinary anesthesia (see graph 1).1 We found that:

1. Resistance increases with flow and for inspiration is generally higher than expiration
2. Resistance varies between and within CBS’s
3. The Humphrey ADE has very high expiratory resistance, exceeding 5 cmH₂O at 40 L/min
4. The Darvall Stingray™ was the only circuit with inspiratory and expiratory resistance < 2 cmH₂O at flows up to 40L/min.

Graph 1: Comparison of Inspiratory Flow Resistance Between Circle Breathing Systems vs. Peak Inspiratory Flow Rate (L/min).

Graph 2: Comparison of the rate of change of isoflurane concentration (ISO) between a novel circle system - the Darvall Stingray™ Circle Absorber and the Burton’s Cycloflo, Humphrey ADE, Medical Developments hamster wheel, Read Eagle/Eikenmeyer and Surgivet circle systems. Experiment based on a 12lb animal model using a fresh gas flow of 70 ml/min; 12 breaths/min at a Tidal Volume of 100 ml. All systems used Darvall 12" ID smooth wall hoses, a 500 ml rebreathing bag and CO₂ absorber canisters were filled with 3/16" OD polyethylene beads representing soda lime volume. Magenta Line = predicted change based on time constant. The Darvall Stingray™ concentration rises rapidly in the first 30 breaths (2.5 min) and the concentration rises faster in the first 20 minutes compared to other circle systems.7

Rate of Rise in Anesthetic Concentration

In this study we compared the rate of change of isoflurane concentration in the same circle systems (see graph 2).3 We found that the response of Darvall Stingray™, Burton’s Cycloflo, Surgivet and MDI hamster wheel responded more rapidly than the model predicted (at 6.5, 11, 22 & 45lb taking 12-18 breaths before change in the fresh gas concentration was first detected at the Y-piece) and the Humphrey ADE and Read Eagle (Eikenmeyer) were slower (60 and 24 breaths respectively).

Response to Vaporiser Concentration Change in Darvall’s Stingray™ Circle Absorber in 3kg Animals

Graph 3: Darvall Stingray™ Circle Absorber used on 6.5lb animal model at gas flows down to 15 ml/min with 12 breaths/min at a Tidal Volume of 60 ml shows a lightening fast response to vaporizer dial changes. Red Line = predicted change based on time constant.3

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References
3. CI Dunlop, JS Dunlop, RA Curtis et al. Comparison of the dynamic response to changing anaesthetic concentration in circle breathing systems used on animals from 3 to 20Kg. Abst.WCVA, Capetown S. Africa Sept 2012