USE OF IMPLANTABLE PORTS FOR POWER INJECTION OF CONTRAST MEDIA

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INTRODUCTION

The injection of viscous contrast media (CM) at high flow rates via a central venous catheter may generate an excessively high pressure in the injection line with a consequent risk of catheter disconnection or rupture[1], extravasation[2] or injector failure. However, lower flow rates (0.5 to 2.5 mL/s) may be insufficient to achieve good contrast enhancement.[3,4] The objective of this *in vitro* study was to assess the feasibility of injecting CM into implantable ports (IP) and to establish safety guidelines.

MATERIALS AND METHODS

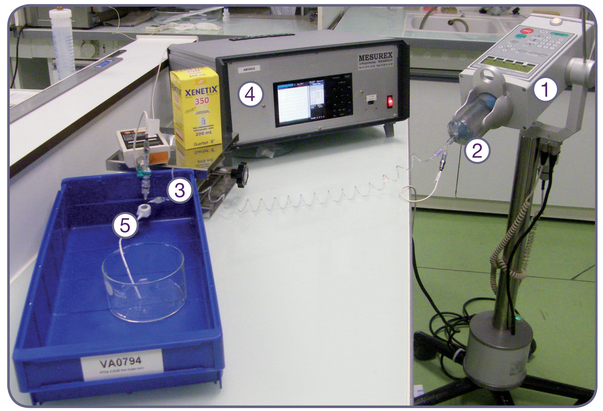
- Eleven IP models marketed by four different manufacturers were tested: Polysite® micro (2005, 2015), mini (3007, 3008, 3017), standard (4008) and High Flow (4019, 40010) (PEROUSE MEDICAL), PowerPort® (Bard), T-Port LP k-set (PFM Medical) and Celsite® ST215 (B. Braun)
- The IP were punctured 50 times before the tests, to simulate real-life conditions of use (CM being rarely injected into a newly inserted IP)
- The catheters used were 25 cm long (this length being seldom exceeded in clinical practice)
- Flow rates tested: 1 to 5 mL/s for pediatric IP (Polysite® micro and mini models); 4 to 5 mL/s for adult IP
- In accordance with the recommendations of the IP manufacturers, the CM (Xenetix® 300 and 350; Laboratoires Guerbet) were pre-heated to 37°C before injection
- The pressure during injection was measured:
  - at the injector outlet
  - in the reservoir of the IP tested

  by means of sensors connected to a central data logger
- The safety of the system was evaluated by the absence of
  - injector failure
  - leakage of the IP
  - catheter disconnection or rupture

Complementary tests

- Effect of not pre-heating the CM: injection of Xenetix® 350 at 20°C at 5 mL/s into a Polysite® mini 3008 ISP port connected to an 8F silicone catheter
- Effect of total obstruction of the catheter: injection of Xenetix® 350 preheated to 37°C at 5 mL/s into a Polysite® High Flow 4019 ISP port connected to a clamped 9F polyurethane catheter

The experimental set-up



1. HP Injektron® 82HP injector (MedTron) set at an injection pressure limit of 22 bar (320 psi)
2. Pelicangio® syringe (PEROUSE MEDICAL)
3. Curved non-coring Huber needle (22G, 20G or 19G (PEROUSE MEDICAL) or PowerLoc® 19G non-coring Huber needle (Bard)
4. MESUREX data logger (Graphtec GL800)
5. IP tested

RESULTS

- Injection of CM preheated to 37°C into an IP connected to a patent catheter at flow rates of 1 to 5 mL/s, according to the IP model, resulted in a mean pressure (P_{mean}) measured at the injector outlet of 5.31 to 15.58 bar, while the corresponding P_{mean} measured in the IP reservoir ranged from 1.12 to 4.38 bar (Table 1)
- At the flow rates recommended by the manufacturers of the IP models tested, no leakage or catheter disconnection was detected and the recommended maximum pressure in the IP reservoir was not exceeded
- The pressure curves established illustrate the progressive decrease in pressure along the injection line (Figure 1)
- When the CM was injected with no preheating (at 20°C), the P_{mean} measured in the IP reservoir was increased by 30% (Table 1), approaching the safety limit specified by the manufacturer (4.5 bar)
- Injection of preheated CM into a PI connected to a clamped catheter (simulating catheter obstruction; n = 3 injections), the P_{mean} in the IP reservoir reached > 9 bar, leading to:
  - Catheter rupture (n = 2)
  - Injector failure (n = 1)

Figure 1: Example of a pressure curve along the injection line

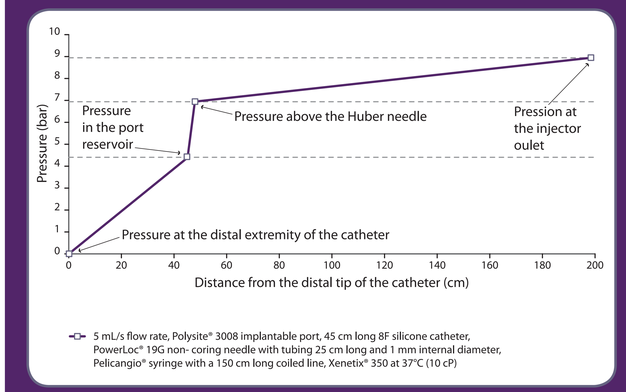


Table 1. Mean pressure at the injector outlet and in the implantable port (IP) reservoir during injection of the contrast agent (CM)

IP model / catheter caliber and composition	Injection conditions (25 cm catheter)	Injection flow rate (mL/s)	Mean pressure in IP reservoir (bar)	Mean pressure at injector outlet (bar)
Polysite® micro 2005 / 5F SI	Xenetix® 300 preheated to 37°C (viscosity: 6 cP)	1 *(n = 18)*	3.09	5.31
Polysite® micro 2015 / 5F PU		2 *(n = 18)*	4.38	9.80
Polysite® mini 3007 / 7F SI	Xenetix® 350 preheated to 37°C (viscosity: 10 cP)	3 *(n = 18)*	3.58	10.82
Polysite® mini 3008 / 8F SI		5 *(n = 18)*	3.39	13.61
Polysite® mini 3017 / 7F PU		5 *(n = 21)*	2.59	15.58
Polysite® standard 4008 / 8F SI		5 *(n = 21)*	3.94	14.13
Polysite® High Flow 4019 / 9F PU		5 *(n = 21)*	1.12	12.41
Polysite® High Flow 40010 / 10F SI		5 *(n = 21)*	1.24	12.62
PowerPort® / 9F PU		5 *(n = 9)*	1.38	12.62
PFM T-PORT LP k-Set® / 8F PU		5 *(n = 1)*	1.38	10.70
Celsite® ST215 / 6.5F SI		4 *(n = 1)*	2.88	18.44
Polysite® High Flow 4019 / 9F PU	Xenetix® 350 preheated to 37°C (viscosity: 10 cP) catheter clamped	5 *(n = 3)*	9.2 *(n = 2)* Catheter rupture	19.5 *(n = 2)*
			9.5 *(n = 1)*	22 *(n = 1)* injector failure
Polysite® mini 3008 / 8F Si	Xenetix® 350 at 20°C (viscosity: 21 cP)	5 *(n = 3)*	4.41 (+30% compared to injection of CM preheated to 37°C)	16.6 (+22% compared to injection of CM preheated to 37°C)

PU: polyurethane ; SI: silicone

CONCLUSION

All the IP models tested can be used for injection of CM at high flow rates on condition that the following precautions are respected:

- **Preheating of the CM to 37°C to reduce their viscosity**
- **Verification of the patency of the catheter (in clinical practice, by obtaining blood reflux).**

The recommendations of the IP manufacturers concerning other parameters, such as the maximum length of the catheter, the choice of a non-coring (Huber) needle adapted to the IP and to power injection, and the maximum flow rate of injection should of course also be respected.

If these conditions are respected all the tested adult IP withstand at least a 3 mL/sec flow rate.

REFERENCES

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