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Contrast medium injectors: Roller pump system vs. syringe system

Thoughts of a radiologist about relevant decision-making criteria
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Administration of contrast medium during CT or MRI examinations is an important component of diagnostic radiology. The use of contrast medium injectors instead of manual intravenous CM administration has been state of the art since the early 1990s for CT examinations (Ref. 1). Technically there are basically two different injector systems: syringe injector and roller pumps. The aim of these deliberations is to evaluate both systems in terms of hygienic safety, handling, consumables and the associated costs.

1. Syringe system

Principle:

A syringe (pre-filled or externally filled 200 mL empty syringe) filled with medium (CM, NaCl) is used for syringe injectors. By pushing the syringe piston the pressure in the barrel is increased, allowing the media to be injected via a system of tubing into the patient.

2. Roller pump system

Principle:

With roller pump injectors, external contrast medium containers (all standard CM container sizes) are attached to the system. An integrated pump generates the pressure for the injection in a two-component tubing system (pump hose and patient hose). The

patient hose is replaced after each patient. The preset direction of rotation of the roller pump means there is only one direction of media flow in the system. There is, therefore, no chance that medium can be drawn retrograde via the pump as is the case with the syringe system.

Single dose vs. multi-dosing: comparison of the systems

Syringe system:

When using the syringe system for a single dose, prefilled syringes of contrast media (50, 75, 100, 125 mL) and for NaCl are used for injection via a tubing system into the patient and thereafter the system is completely replaced by new components. According to statements by the leading manufacturer of a syringe system, there is still no approved prefilled syringe for NaCl in several countries, meaning that the system (still) cannot be operated exclusively with prefilled syringes in the intended single-use form. The injection system must allow two directions of flow in order to fill empty syringes, which are usually used for reasons of cost effectiveness. Contrast medium is aspirated from the original CM and NaCl containers via a transfer set in order to be finally injected into the patient. Aspiration of the contrast medium carries a certain intrinsic risk of contamination, which is greatly compounded (Ref. 2) as a result of the possible, and therefore routine and common, practice of re-using components, although this is not intended by the manufacturer. As a CM and a NaCl container are used for a number of patients in succession and only the patient tubing is replaced for each patient, this delivery system is actually a type of **multi dosing**.

Roller pump system:

For roller pump systems that are approved in Austria for **multi dosing** under sterile conditions, the bulk, and therefore cost-effective, media containers (various manufacturers) usually used are connected to the system and left there until they are emptied. After each patient, the patient part of the two-part tubing system, which is secured by check valves, is replaced. The pump hose on the other hand is approved for use of up to 24 hours, taking into consideration the relevant information from the contrast medium manufacturer. One CM manufacturer writes, for example, that used CM must be discarded 10 hours after the container is first opened, while other manufacturers do not give any time limits and refer to the information provided with the injector.

Safety aspects of both systems

Filling injection syringes, as is necessary with a syringe system used for multi dosing, is considered a safety risk due to the potential risk of contamination. Such a system should ideally only be implemented as an entirely disposable system using prefilled syringes (single dose), which is admittedly—as mentioned—(still) not possible in Austria due to the lack of availability of prefilled syringes. This stands in contrast to the roller pump system: the CM and NaCl original containers are attached to the system under sterile conditions and left there only until the medium is consumed (see above). Filling empty vessels, which is considered very critically by hygienists, is not even possible with this system, as the roller pump is designed so that only one direction of flow towards the patient is permitted. Together with additional technical parameters, such as separation of contrast medium and patient tubing systems, exchange of the latter after each patient and the use of two check valves, a high level of hygienic safety is assured in terms of bacterial or viral contamination of the tubing. A microbiological study and two virology reports confirm this (Ref. 5–7).

Evidence-based medicine

The evidence was then considered of whether the safety associated with multi dosing using a roller pump system, which has predominated in Austria to date, is comparable in terms of bacterial or viral contamination of patients with a syringe system, which involves replacement of all components after each CM delivery, that is, it is a disposable system. Randomized, controlled studies, systematic reviews or meta analyses (as of 11/2009) were researched that represented the best possible evidence as they displayed the least potential for systematic errors, bias or confounding. The very comprehensive research came to the conclusion that there is currently no evidence available which suggests a preference for or rejection of either of the two pump systems.

This means from a safety point of view there is nothing that discounts the use of multi dosing with the roller pump system, which is also expressly approved for such use. The syringe system, on the other hand, should only be implemented as a disposable system with prefilled syringes or empty syringes. The authors of a recently published Austrian article also came to the conclusion that although a disposable system is the ideal, they nevertheless suggest that the roller pump system can also be safely operated with correct handling (Ref. 8).

Differences in operating costs, handling, time required

CM delivery via a roller pump system in multi dosing mode is the most commonly used CM injector system in use in Austria. As described above, both systems are considered hygienic if correctly operated. There are, however, fundamental differences in terms of costs, handling and time expenditure. The costs of consumables (excluding contrast media) for syringe systems are about twice that of roller pump systems, calculated on the basis of 5 contrast administrations per day (market price in Austria). The cost ratio is increasingly shifting in favor of the roller pump system. The use of syringes prefilled with contrast medium from one manufacturer does commit the user to this product, which may limit the freedom to choose the contrast medium as well as the ability of the user to negotiate costs.

The rapid technological development of CT and MRI scanners has led to increasingly shorter examination times, such that the preparation time is the second-most important time factor after the patient turnaround time. The replacement and disposal of all components of a syringe system after each patient represents a greater handling requirement for this system which is in turn associated with a greater time expenditure compared to the roller pump system for which only the patient tubing must be replaced after an injection.

Conclusion

Hygienic safety, economic aspects and handling and time expenditure are the central parameters when assessing the operation of a contrast medium injector. Both the syringe injector using disposable syringes and the roller pump system (multi dosing) are identical in terms of hygienic safety according to the criteria of evidence-based medicine. However, the syringe system cannot be operated as an entirely disposable system due to the absence of NaCl prefilled syringes. There are, however, significant differences—as described— in the costs for consumables, in handling and the time expenditure (see Table). These direct and indirect operating costs must subsequently be weighed against the intended service lifetime and the acquisition and maintenance costs of the particular system. Each user must therefore individually calculate and compare the real costs of the systems.

Table 1: Comparison of syringe injector and roller pump systems

System	Safety	Time required for handling	Operating costs	Comments
Syringe injector	= (as disposable system)	↑	↑	- with CM prefilled syringes depends on manufacturer - NaCl prefilled syringes currently not available in Austria - empty syringes max. 200 mL - questionable in terms of safety due to possible repeated filling
Roller pump	= (multi dosing)	↓	↓	- contrast flow direction only towards patient - all CM container sizes can be used

References

(1) SG Miles, et al. Safe use of an intravenous power injector for CT: experience and protocol, Radiology 1990;176:69–70

(2) Working Group for Hospital Safety (Healthcare)in Municipal Department 15 of the City of Vienne, Safety File, March 2004, Recommendation No. 23

(3) B. Buerke et al, Injektionsautomaten in der Magentresonanz- und Computertomographie: Pilotstudie zu hygienischen Aspekten. [Automatic injectors in magnetic resonance imaging and computed tomography: pilot study of safety aspects] RöFo 2004;176:1832–1836

(4) B. Buerke et al., Microbiologic contamination of automatic injectors at MDCT: experimental and clinical investigations, AJR 2008;191:283–287

(5) K. Frösel, Mikrobiologische Effizienzkontrolle, [Microbiological Efficiency Monitoring] Medical Device Services, 2003

(6) B. Wiedemann, Gutachten zur mikrobiologischen Sicherheit des ulrich-Injektor-Systems zur Injektion von Röntgen-Kontrastmitteln,[Report on the microbial safety of the ulrich injector system for the injection of X-ray contrast medium] 2007

(7) W.H. Gerlich, Gutachterliche Stellungnahme zur Validierung der Kontaminationssicherheit des Kontrastmittel-Injektionssystems missouri XD [Expert report on the validation of the contamination safety of the missouri contrast medium injection system] 2001, 2006

(8) Pichler et al., Hygieneaspekte bei Kontrastmitteluntersuchungen,[Safety aspects in contrast medium examinations] Wiener Klinisches Magazin 2009;12,3

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