IS HIGH FLOW INJECTION THROUGH CENTRAL CATHETERS SAFE FOR TOMOGRAPHIC STUDIES?

¿ES SEGURA LA INYECCIÓN DE ALTO FLUJO A TRAVÉS DE CATÉTERES CENTRALES PARA REALIZAR ESTUDIOS TOMOGRÁFICOS?

Catalina Cuervo Valencia1
Milena Alcázar Paternina1
Liliana Arias Álvarez2
Marcela Montoya3
Milagros Martí de Gracia4
Germán Alberto Castrillón5

Summary

Objective: The objective is to demonstrate the safety of medium contrast mechanical injection through central lines, not through a hemotherapy port or a hemodialysis catheterer, at rates > 3 ml/sec.

Methods: We performed a descriptive, longitudinal and prospective injection in patients who had a central line as the only venous access, and who underwent a mechanical injection with medium contrast at a rate 3-4 cc / sec. We evaluated complications in hemodynamics and complications related to the integrity of catheters.

Results: 20 patients were injected via central venous catheters (CVC) and 35 patients via peripherally inserted central catheters (PICC). No complications were observed related to the integrity of the catheter.

Conclusion: Medium contrast mechanical injection, performed through CVC and PICC at rates between 3 and 4.5 ml / sec, is considered a safe and viable alternative to contrast-enhanced CT.

Key words (MeSH)
Injections
Contrast media
Catheters
Catheterization, central venous
Tomography

Palabras clave (DeCS)
Inyecciones
Medios de contraste
Catéteres
Cateterismo venoso central
Tomografía

Resumen

Objetivo: Demostrar la seguridad de la inyección mecánica de contraste a través de catéteres centrales, excluyendo catéteres de hemodiálisis y puertos de quimioterapia, a velocidades > 3 ml/seg. Métodos: Se realizó un estudio descriptivo, longitudinal y prospectivo en pacientes hospitalizados, quienes tenían como única vía de acceso una línea central y en quienes se les realizó inyección mecánica de medio de contraste a una velocidad de 3 y 4 cm³/seg. Se evaluaron las complicaciones hemodinámicas y relacionadas con la integridad de los catéteres. Resultados: Se inyectaron 20 pacientes a través de catéteres venosos centrales (CVC) y 35 pacientes a través de catéteres centrales de inserción periférica (CCIP). No se presentaron complicaciones hemodinámicas ni se observaron complicaciones relacionadas con la integridad del catéter. Conclusión: La inyección mecánica de medio de contraste a través de CVC y CCIP, utilizando velocidades entre 3 y 4,5 ml/seg es una alternativa segura y viable para tomografías contrastadas.
Introduction

La inyección mecánica de medio de contraste para la realización de imágenes de tomografía computarizada (AngioCAT) es un factor fundamental en la calidad de los estudios que garanticen una uniforme distribución del medio de contraste en los diferentes tejidos, lo que puede ser documentado en la literatura. Los pacientes que no tienen acceso venoso periférico son comunes en los hospitales. Por lo tanto, su único acceso es el catéter central, ya que estos catéteres son una alternativa para la inyección de medios de contraste a altas tasas.

Las tasas de inyección de medio de contraste para estudios contrastados varían entre 3-5 ml/sec, y suelen ser más altas cuando se requiere una angiografía (10,17-21). Estas tasas son mucho más altas que las tasas de inyección manual del medio de contraste (5-9). Estas tasas son mucho más altas que las tasas de inyección manual del medio de contraste (5-9). Estas tasas son mucho más altas que las tasas de inyección manual del medio de contraste (5-9).

The effect of the contrast medium mechanical injection by central catheters has not been sufficiently studied, and most manufacturers of these catheters do not provide guides for the utilization of mechanical injectors in these catheters (1).

Low rates of complications have been reported in 0.1% of cases associated with the usage of mechanical injectors through peripheral catheters, (1-4). However, this access is not available in some cases, either due to the impossibility of channeling a vein due to thrombosis, or due to phlebitis of the peripheral veins. In these cases, a central path must be evaluated as an alternative to contrast medium injections (5-9).

The purpose of this study is to prove that contrast medium mechanical injections through central venous catheters at rates between 3 and 4 ml/sec are safe. However, chemotherapy ports and hemodialysis catheters are excluded from this study. Chemotherapy ports are already recommended for this purpose, and hemodialysis catheters are excluded due to the risk of infection associated with the manipulation by external personnel of nephrology services.

Materials and methods

A descriptive, longitudinal, and prospective study was performed for patients in a level IV hospital, in the city of Medellín, Colombia, between March of 2010-March of 2012.

Inclusion criteria

The inclusion criteria were patients over the age of 18 whose renal function was normal. These patients had a central line as the only venous access, and were administered an intravenous contrast medium through the central line, at a rate between 3 and 4 ml/sec.

Exclusion criteria

Patients who had doubts regarding the location and/or integrity of the catheter were excluded, as well as patients with Swan Ganz catheters, of hemodialysis and chemotherapy ports, and patients who presented allergic reactions before the contrast medium.

Procedure

All patients who were taken to the computerized tomography service were assessed in a study that required the administration of an intravenous contrast medium. The venous access paths were verified. In case only a central path existed, the patient was admitted into the research protocol. Subsequently, a researcher started with the informed consent approval and after that, started the recollection of the demographic and clinical variables which included the relevant background, the indication, and the type of performed exploration in a written format.

Questions were answered, and if the patient was in agreement, he/she signed the document with at least one witness present.

Thereupon, the patient was taken to the scanner, where the permeability and the adequate intravascular position of the catheter were verified. A saline solution was administered at first through manual injection. The permeability of the catheter was confirmed when the passage of the saline solution was performed without difficulty. The injection was not performed if there were any doubts regarding the integrity or the adequate location of the catheter. When said location and the permeability of the central catheter was confirmed, the injection of the contrast medium was started, and the rate of injection and type of catheter were registered.

A non-invasive monitoring of vital signs was performed before, during, and after the contrast medium injection and any complication was logged in a format meant for this purpose. The following logs were assessed: Systolic arterial pressure (SAP), diastolic arterial pressure (DAP), pulse, oximetry, and manifestations which could suggest reactions to the contrast medium, such as nausea, vomiting, outbreaks, itching, dyspnea, anaphylaxis, cardiopulmonary arrest, among others. These logs were monitored during the administration of the contrast medium, up to an hour later.
Complications related to the catheter were evaluated, regarding a possible malfunction with subsequent difficulty in the passage of medications or liquids, occlusion, thrombosis, total or partial rupture, and in case it occurred, the location of the rupture and of the possible embolization of the distal fragment. In order to obtain this information, clinical history was reviewed and the nursing staff in charge of detecting difficulties with the catheter up to 24 hours after contrast medium mechanical injection was contacted.

All the explorations took place in a General Electric LightSpeed VCT XT General Electric 74 detector multi-cut scanner, according to the protocol established for the disease or for the respective diagnostic impression.

All patients were administered a water soluble iodinated contrast medium through the mechanical injector Medrad Stellant SCT-210, with volumes between 80 cm³ and 100 cm³ and concentrations of 300 and 350 mg/ml (for AngioCAT). The injection had a pressure of 300 pounds per square inch (PSI) at a rate over 3 ml/second.

Statistical analysis

Frequency distributions were used in the statistical data analysis when the variables were qualitative. The summary and central tendency measures were used for quantitative variables, after using the Shapiro Wilk test for their distribution. Additionally, an analysis of related samples was performed. This was done to compare whether there were significant differences in the pulse and oximetry of patients in their basal condition, during the moment of injection, and an hour after being injected. The Wilcoxon range test was used for this purpose, due to the abnormal distribution of the implied quantitative variables.

The McNemar test was used to evaluate changes in the arterial pressure numbers of each patient. PAS numbers between 90-140 mmHg were considered and PAD numbers between 60-90 mmHg and 350 mg/ml (for AngioCAT). The injection had a pressure of 300 pounds per square inch (PSI) at a rate over 3 ml/second.

Results

From the 55 patients included in this study, 26 were women (47.3%), and 29 were men (52.7%). The average age of the patients was 53 years (15 to 85 years of age). In terms of personal background, 20 patients had high blood pressure (36.4%), 11 patients were diabetics (20%), 2 suffered from coronary disease (3.6%), 2 had a background of arrhythmia (3.6%), and 2 had suffered from allergic reactions; one to penicillin and the other to tramadol (3.6%).

The creatinine serum levels before the study had an average of 0.9 mg/dl, with a range between 0.4-8.8 mg/dl.

The main indications of tomographic studies were infection (30.9%), pulmonary thromboembolism (25.5%), others (43.6%).

Contrasted tomographic studies were performed on 34 patients and angioCAT studies were performed on 21 patients, with a nonionic iodinated contrast medium: Iohexol (OmnipaqueTM).

All the assessed catheters were Arrow brand. Their material is polyurethane. CVC with a caliber greater than 5 Fr and a length between 16-20 cm was used in 20 patients (36.4%), and CCIP 5 Fr with a length of 50 cm was used in 35 patients (63.6%). 27 of these catheters were single lumen (49.1%), 25 were bilumen (45.5%), and 3 were trilumen (5.5%).

The rate of injection was 3.0 ml/sec for 34 patients (62%), and 4.0 ml/sec for 21 patients (38%).

When monitoring was performed in order to detect complications related to the catheter during the first 24 hours after injection, no cases presented an extravasation of the contrast medium, total or partial rupture of the catheter, dysfunction, embolization, occlusion, or thrombosis. No complications related to the patient were reported one hour after the contrast medium injection, evaluating outbreaks, itching, dyspnea, anaphylaxis, nausea, vomiting, cardiopulmonary arrest, among others.

No significant variations of systolic or diastolic arterial pressure were detected when evaluating the vital signs of the patient before, during and up to one hour after the injection of the contrast medium. These variations were not detected either in the pulse or oximetry of patients (table 1).

Discussion

The results of the study reveal zero complications associated to the contrast medium injection with a high flow in patients who also presented associated morbidity.

The Plumb and Murphy revision (22) also shows a very low incidence of complications, as well as 6 adverse effects in 858 cases (0.7%). These events were related to the catheter and were the rupture and obstruction of the catheter. The solution of these cases consisted of the change of the catheter. This situation did not affect the clinical prognosis of patients (22).

The most important factor in the decision of using central lines for the contrast medium injection is to establish its need in order to manage the patient. If the contrast medium is necessary, the benefit can justify the risk.

In case the contrast medium injection is needed, these same authors recommend rates under 2 ml/sec and the verification of the permeability and the adequate position of the catheter, whether by previous radiographies or in the topogram. However, angioCAT studies clearly require a good enhancement of vascular structures, which improve as injection rates increase (23); rates under 2 cm/sec may not be enough to achieve this objective.

The study performed by Sanelli PC. and collaborators regarding 104 dynamic studies of contrasted tomography did not show immediate or early complications related to the catheter. Cardiovascular complications were not observed either. These used central catheters for the contrast medium injection, with rates between 3-5 ml/sec (12).

The results described in the Plumb and Murphy meta-analysis (22), in the study performed by Sanelli and collaborators (12) included in

Table 1. Variations of PAS, PAD, pulse and oximetry numbers.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Basal</th>
<th>Injection</th>
<th>Valor p</th>
<th>Post</th>
<th>Valor p</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAS</td>
<td>130 (69-190)</td>
<td>131 (90-200)</td>
<td>0.926</td>
<td>120 (66-190)</td>
<td>0.010</td>
</tr>
<tr>
<td>PAD</td>
<td>70 (40-113)</td>
<td>73 (44-178)</td>
<td>0.854</td>
<td>68 (8-100)</td>
<td>0.160</td>
</tr>
<tr>
<td>Pulso</td>
<td>88 (50-113)</td>
<td>89 (8-130)</td>
<td>0.592</td>
<td>89 (56-130)</td>
<td>0.479</td>
</tr>
<tr>
<td>Oximetría</td>
<td>95 (83-100)</td>
<td>95 (83-100)</td>
<td>0.834</td>
<td>96 (83-925)</td>
<td>0.830</td>
</tr>
</tbody>
</table>

Average (min-max), p value = Test. T of the Student for related samples
saying meta-analysis, and the results in this article series can be a start-
ing point to initiate the protocol process of the use of central lines for
contrast medium mechanical injection, both for tomographic as well
as angioCAT studies.

The benefit clearly seems to be greater than the risk. As described,
complications related to the catherer do not reach 0.7% (12,22).

Therefore, the injection with contrast medium mechanical injectors
at rates between 3 and 4 ml/sec through CVC and CCIP is an adequate
and viable alternative for routine contrasted topographic and angioCAT
studies, with the same safety as in lesser injection rates. This was sub-
sequently communicated to the manufacturer. Even if the manufacturer
had in vitro support if the injection to this velocities was adequate, it did
not have in vivo support, which was recommended with the precautions
described in the product information.

This study shows different limitations which include a small number
of patients, and the non-inclusion of pediatric patients. For this reason,
the results cannot be extrapolated to population who use catherers
with a lesser diameter. The usage time of the central catherer was not
studied either, given that it could have conditioned a greater theoretical
number of complications.

Even though the study proves the safety of the contrast medium
injection through central catherers, it is important to have an institutio-
nal protocol in place for catherer injections. The protocol would start
with the explanation of the procedure benefits and risks, reaching a
conclusion with the treating team to subsequently obtain the approval
of the patient and/or his/her family. This is done so that the position
and permeability of the catherer can be verified, proceeding to the
contrast medium injection with the appropriate rate for the clinical
indication of the patient.

In conclusion, one could say that if the results hereby presented were
to be used, one could improve the possibility to access image studies
for all patients without peripheral venous access and who exclusively
have a central venous access. Using the precautions described in this
article, one could inject with rates greater than 3 ml/sec.

Acknowledgments

Sustainability project of the research vice-rector’s office of the
Universidad de Antioquia, Medellín, Colombia.

Referencias

catheter material through central venous catherers for CT: In Vitro evaluation. Radiology.
1996;200:731-5.

2. McCarthy S, Moss AA. The use of a flow rate injector for contrast-enhanced com-

3. Miles G, Rasmussen F. Safe use of an intravenous power injector for CT: Experien-

4. Stistrom CL, Gay SB, Peffley L. Extravasation of iopamidol and iohexol during

5. U.S. Food and Drug Administration. Reminders from FDA regarding ruptured
vascular access devices from power injection [internet]. 2012 [citado 2013 jul. 15].
Disponible en: www.fda.gov/.


injection through currently available PICCs: An in vitro study. J Vasc Intervent Radi-

8. Coyle D, Bloomgarden D, Beres R, et al. Power injection of contrast media via peri-

POR QUÉ CONFORMARSE CON LO QUE LE OFRECEN, SI PUEDE TENER TODO LO QUE NECESITA.*

Conocemos qué necesita y cómo lo necesita, por eso contamos con la solución indicada para su Compañía.

Hiruko RIS - Hiruko PACS - Hiruko TLRAD

* Soluciones Tecnológicas para Imágenes Diagnósticas

Software as a Service

www.imexhs.com