Letter to the Editor

The use of N-butyl cyanoacrylate for embolization of bleeding patients must be demystified regardless of the operator experience

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I read with great interest the article by Grange *et al.* recently published in *Quantitative Imaging in Medicine and Surgery* and evaluating the safety, efficacy and impact of operator's experience of N-butyl cyanoacrylate (NBCA) as an embolic agent in emergency transcatheter arterial embolization (TAE) (1).

I have several comments. First of all, I would like to congratulate the authors for their work which represents the only study available to date assessing the role of interventional radiologist's (IR) expertise in using NBCA glue in such a setting.

TAE has gained widespread acceptance in clinical practice as a first-line therapy for emergency arterial bleedings over time, regardless of the anatomical territory and the cause of bleeding (2-4). Mixed embolic agents such as coils or particles have emerged as the currently preferred embolic agents for this purpose (2,3). NBCA has been used increasingly as well over the last decade for bleeding patients (4-6). It is particularly interesting in hemodynamically unstable patients and in cases of underlying coagulopathy, because it usually provides faster and better hemostasis than other embolic agents, which is very beneficial on an emergency basis (7,8). However, historically, glue had a very bad reputation in the IR community, with a common belief that its use is quite difficult and should be reserved for trained and skilled operators. Although conclusions from the present study must be drawn with caution because of its retrospective nature, the authors demonstrated that the clinical success, mortality during follow-up, 30-day mortality, complications and recurrence of bleeding were not significantly different based on the operators' experience ($P>0.05$), with a threshold of 3 years. As reported here, this finding challenges the common belief about the difficulties of using this embolic agent, regarding non-target embolization. I am in line with the authors on that feature.

First, in our experience, glue has no more risk of complications than any other embolic agents if properly used (4,6,7). Second, the few events of non-target embolization which may happen in visceral interventions have no serious clinical consequences in the majority of cases, and then this should not be a hindrance to its use. Third, NBCA has many well-known advantages from a technical point of view in terms of navigability, visibility, versatility, efficacy and duration of vessel occlusion (8,9). It is especially true in patients with compromised spontaneous thrombosis since polymerization and vessel occlusion do not depend on coagulation parameters, making it an embolic agent of choice in case of coagulopathy, as previously reported (7). These technical advantages can even translate into better clinical outcomes, not only for bleeding patients, as reported in many situations (7-11). For these reasons, in our institution, TAE using glue as the only embolic agent has become the salvage treatment of choice in bleeding patients. It is then of utmost importance

to highlight that NBCA usage must be demystified and democratized within the entire IR community, especially among the young generation of IRs, in the interest of patients. Based on the current findings, the use of NBCA by young operators may be actively recommended. On the other hand, the present study demonstrated that the learning curve for operators in using NBCA properly in emergent situations is quite short if well supervised (1). Fourth, overall outcomes were particularly good, with a clinical success, early rebleeding, major complications, and 1-month mortality rates of 82.3%, 4.4%, 0%, and 13.3%, respectively. These good outcomes were reported despite a high proportion of patients with active bleeding (68.1%) and hemodynamically unstable (43.4%), meaning with more severe condition and at higher risk of rebleeding. We can then assume that the absence of glue use in this population could have led to worse outcomes than expected with other embolic agents, reflecting the fact that glue TAE was finally of utmost importance in these selected patients (1). Last, I was surprised by the 1/1 NBCA/Lipidiol® ratio used in the majority (45.1%) of patients, the trend being to use a more diluted mixture such as 1/3 or 1/4 ratio in most of arterial bleeders in order to obtain a more distal embolization (4,11).

In conclusion, like the authors, our experience suggests that TAE using cyanoacrylates alone or in combination with other embolic agents, is generally very effective, fast and safe in controlling acute arterial bleeding, regardless of the anatomical territory. Additionally, I fully agree that operator experience should no longer be considered as a key factor for outcomes.

Appendix 1: Response to "The use of N-butyl cyanoacrylate for embolization of bleeding patients must be demystified regardless of the operator experience".

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Footnote

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Ethical Statement: The author is accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Supplementary

Response to "The use of N-butyl cyanoacrylate for embolization of bleeding patients must be demystified regardless of the operator experience"

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First, we would like to sincerely thank Professor Loffroy for his careful reading of our study on the role of N-butyl cyanoacrylate (NBCA) in emergency embolization, published in *Quantitative Imaging in Medicine and Surgery*, as well as for his insightful comments (1,2). His long-standing expertise in this field brings valuable perspective to the ongoing discussion about the optimal use of NBCA, an embolic agent that still inspires both enthusiasm and hesitation within the interventional radiology (IR) community.

Despite its well-recognized efficacy, NBCA remains underused in daily practice, largely because of its enduring reputation as a "dangerous" or "difficult" material to handle. This perception explains why many IRs continue to favor coils or particles. As Professor Loffroy rightly emphasized, this reputation is largely unjustified when NBCA is correctly prepared and delivered.

We made the choice to familiarize our team with NBCA at an early stage, specifically for hemostatic embolization. From this experience, we have drawn the following lessons:

(I) NBCA is not more dangerous than other embolic agents, and is probably more effective (2);

(II) When the target artery cannot be reached due to arterial tortuosity, NBCA remains the only reliable embolic agent (3);

(III) NBCA, either alone or in combination with coils, should be recommended for the treatment of gastroduodenal peptic ulcer hemorrhage with active bleeding, in order to achieve distal embolization and prevent early recurrence from the pancreaticoduodenal arcades (4);

(IV) NBCA is the most effective embolic agent for percutaneous image-guided embolization of pseudoaneurysms, either as a first-line option or after endovascular technical failure (5,6).

We fully share Professor Loffroy's view on the essential role of supervision and training. NBCA should be introduced at the very beginning of emergency embolization practice under senior guidance. Early familiarization with preparation, and slow injection allow trainees to gain confidence and acquire the technical skills and procedural reflexes needed for safe and effective use in emergency settings.

Another important point concerns NBCA dilution. The NBCA/Lipiodol ratio must always be adapted to the clinical scenario. In high-flow arteries, a low-dilution mixture may be preferable to promote rapid polymerization and avoid non-target embolization. When the bleeding point is close to the microcatheter tip, particularly in low-flow or terminal arteries, a small volume of glue, at any dilution, may be sufficient, combining efficacy with safety. We also fully agree that when the target artery cannot be reached, a high dilution (≤1/3) should be prepared. This adaptation of dilution strategy to anatomy and hemodynamics is one of the most interesting aspects of NBCA embolization and should be systematically taught to trainees. Finally, we advise against using the 'sandwich' technique (dextrose-NBCA/Lipiodol mixture-dextrose), as it promotes non-target embolization and reduces the efficacy of glue.

In conclusion, we would like to once again thank Professor Loffroy for his constructive remarks and his support for the broader adoption of NBCA. The barriers limiting its use are psychological rather than technical. By standardizing its teaching and ensuring supervised training, NBCA can become a routine tool in emergency embolization. Democratizing the use of NBCA is not only

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desirable but also imperative to ensure optimal outcomes.

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