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Key points:

- Soft tissues cement leakages or spindles malposition are a non-rare occurrence during cementoplasty, and may cause technical failure and/or chronic pain
- Most soft tissue cement fragments and malpositioned spindle can easily be extracted using simple percutaneous techniques

Abbreviations and acronyms

- CBCT: Cone Beam Computed Tomography
- CT: Computed Tomography
- IRB: Institutional Review Board
- PMMA: Poly-methyl-methacrylate

Ethical approval:

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

The study received approval from our local institutional review board (IRB). Patient signed consent was waived by our local IRB.

Abstract

Objectives

Cement leakages in soft tissues are a common occurrence during cementoplasty. They may cause chronic pain, and thus treatment failure. Spindle malposition during reinforced cementoplasty may cause vascular, nerve or cartilage injury. Our goal was to evaluate the rate of cement leakage / spindle extraction and describe the techniques used.

Methods

This retrospective monocenter study included 104 patients who underwent reinforced cementoplasty and 3425 patients who underwent cementoplasty between 2012 and 2020. Operative reports and fluoroscopic images were reviewed to identify extraction attempts and their outcomes.

Results

Six patients (5.8%) had a malpositoned spindle, and all of them underwent spindle extraction during reinforced cementoplasty, with an 80% success rate. A total of 7 attempts were performed, using 2 different techniques. One thousand one hundred thirty patients (32%) had a cement leak in soft tissues, and 7 (0.6%) underwent cement leakage extraction during cementoplasty, with a 100% success rate. A total of 10 attempts were performed, using 3 different techniques. No major complication related to the extraction procedures occurred.

Conclusions

Spindle malpositions and soft tissue cement leakages are not uncommon. We described 5 different percutaneous techniques that were safe and effective to extract spindles and paravertebral cement fragments.

INTRODUCTION

Cementoplasty is a minimally invasive technique for symptomatic fractures or mechanically compromised bone lesions, providing pain relief, both at short and long-term follow-up, and stabilization preventing bone collapse [1, 2]. Although the procedure is generally considered safe, complications may occur during cementoplasty [3]. Cement leakage is the most common one, observed as frequently as in 59.7% of the cases for vertebroplasty [4]. Cement leakage in soft tissues is a common issue, estimated to occur in 21% of the cases. Such soft tissues leakage may sometimes cause chronic pain, leading to treatment failure [5].

Reinforced cementoplasty (percutaneous internal fixation using dedicated spindles combined with cementoplasty**)** provides significant pain relief, and additional resistance to secondary fracture, by inserting spindles in the target bone, compared to non-reinforced cementoplasty [6]. Possible complications include malpositioned spindle, which may cause pain or functional impairment.

With a growing number of procedures over the last decades, developing safe techniques is of the utmost importance. While preventing the above-mentioned issues is preferable, developing strategies to remove the foreign body, whether it is cement leakage or a spindle, can help salvage a procedure gearing towards failure and thus benefit the patient [7]. Several percutaneous techniques have been described to remove such foreign bodies complicating bone percutaneous interventions [8, 9], using a supple biopsy forceps for instance [10]. However, large series focused on this topic are lacking.

The purpose of our study was to evaluate the rate of cement leakage/spindle extractions in a large cohort of cementoplasties. We also aimed to describe the different percutaneous strategies and techniques that may be used to extract such foreign bodies.

MATERIAL AND METHODS

This is a single centre, retrospective, observational study performed according to the STROBE guidelines [11]. Our local institutional review board (IRB) approved the study protocol (IRB approval # HJ 26 6 20a). The need for patients' informed consent was waived by our IRB. This work adheres to the World Medical Association Declaration of Helsinki. Risks and benefits of the procedures were clearly explained to the patients involved in this study, and informed consent to the procedures was obtained from all participants.

Study population

We screened all patients who had a CT scan performed in our hybrid angiosuite from January 2012 to September 2020 and all patients in our institutional database of cementoplasties. We reviewed clinical charts of all eligible patients for inclusion and exclusion criteria.

Inclusion criteria were (a) patients aged 18 or more; (b) patients who underwent cementoplasty or reinforced cementoplasty at our institution.

Exclusion criteria were (a) imaging data unavailable; (b) medical chart unavailable.

Recruitment flow chart is displayed in **Supplemental Fig. 1**.

Clinical and paraclinical data

We reviewed all patients' medical chart for clinical data, including age, sex, fracture aetiology. We reviewed all operative reports and images for procedural data, including procedure type, target lesions, presence of cement leak. We assessed through operative reports and fluoroscopic images whether cement extraction or spindle extraction or repositioning were performed.

Procedures' protocol

Procedures were performed under conscious sedation or general anaesthesia, either in a single plane hybrid angiosuite with a CT-scanner (Miyabi Emotion 16, Siemens) or in a biplane angiosuite. We used either 13G or 11G bone needles (Thiebaud) and poly-methyl-methacrylate (PMMA) bone cement (Biomet UK Ltd) to perform cementoplasty. We used 9G or 8G bone needles (Thiebaud) and 2.5-mm diameter spindles (material: stainless steel in accordance with the international standard AISI 316 L [Thiebaud]) (length ranging from 5 to 8 cm) for reinforced cementoplasty.

Spindle and cement extraction

Spindle malposition systematically led to spindle repositioning or extraction during the procedure. Malpositions include (a) para-vascular location; (b) para-neural location; (c) intra-articular location. Two different techniques, described below, were used; chosen at the operator's discretion.

Spindle extraction: the supple biopsy forceps technique

The bone needle used to insert the spindle is left in place if possible. Otherwise, a large (8G or 9G) bone needle is inserted under fluoroscopy using the same path used for the spindle insertion, and the spindle is “catheterized”. Great attention should be paid to avoid pushing forward the spindle while trying to recatheterize it. A supple biopsy forceps (AN/AMHBFC-WC, Life Partners Europe) is inserted within the bone needle, until contact with the spindle. The clamp is then opened as much as possible inside the bone needle. The biopsy forceps is then pushed forward slightly and the clamp closed to grab the spindle. While maintaining the forceps’ clamp closed, it is gently pulled until extraction of the spindle. Fluoroscopy is used to guide the forceps. Several attempts are often necessary, as friction between spindle and bone is important. With this technique, it is possible to reposition and reuse the spindle. The technique is illustrated in **Fig. 1** and **Supplemental Video 1**.

Spindle extraction: the cementing technique

Similarly to the technique described above, the bone needle used to insert the spindle is either left in place or re-inserted in order to “catheterize” the spindle under fluoroscopy, so that at least half the spindle is within the bone needle’s lumen. As for the previous technique, the operator should recatheterize the spindle very carefully to avoid pushing it more distally. PMMA bone cement is then injected very gently within the bone needle under fluoroscopy so that the cement fills the lumen, most importantly around the spindle. Cement must not leak at the distal aspect of the bone needle (in the target bone), otherwise there is a risk for the spindle and the needle to stay stuck in the bone. Afterwards, the operator waits for the bone cement to harden (around 20 mins for the Biomet V PMMA cement). The bone needle is not moved or rotated during this time interval, as the objective is the spindle, the cement and the bone needle core to be solidarized together. Once cement polymerisation is completed, the bone needle is then withdrawn with the spindle stuck inside. Neither the spindle nor the bone needle can be reused. The technique is illustrated in **Fig. 2** and **Supplemental Video 2**.

Cement leakages did not systematically lead to cement extraction. While extraction was ultimately the operator's decision, consensual indications at our Institution are (a) cement in soft tissues with a length > 3 cm; (b) foraminal location; (c) painful subcutaneous location. Several techniques, described below, were used; chosen at the operator's discretion.

Cement extraction: the resheating technique

For cylindrical shape cement leaks, related to a cement column within the dead space of the bone needle, released during its withdrawal, extraction can be achieved using the same bone needle. The bone needle is inserted using the same initial entry point and pushed toward the cement leak under fluoroscopy. The mandrel is removed, and the bone needle used to catheterize the cement fragment under fluoroscopic guidance, like a sheath on its sword. Upon catheterizing as much of the cement cylinder as possible (ideally up to the vertebral pedicle), the needle is angulated to bend and break the cement cylinder. The needle is then withdrawn while maintaining it angulated so that the cement stays inside the lumen. The technique is illustrated in **Fig. 3** and **Supplemental Video 3**.

Cement extraction: the supple biopsy forceps technique

This technique has been previously described in the literature [10]. A supple biopsy forceps is inserted through the incision and navigated under fluoroscopy, clamp closed, toward the cement fragment. Optionally, the supple biopsy forceps can be navigated inside a rigid bone needle, which can make reaching deeper targets easier. Upon reaching the fragment, the clamp is opened, and the biopsy forceps navigated further to grab the fragment. The supple biopsy forceps is then withdrawn with the clamp kept closed, and the cement fragment is pulled alongside. Several attempts may be necessary to break the fragment free from the cement inside the patient's bone. The technique is illustrated in **Supplemental video 4**.

Cement extraction: the needle holder technique

The initial incision is enlarged using a surgical scalpel blade No. 11. A needle holder is inserted through the enlarged incision and moved toward the cement fragment under fluoroscopy. Its jaws are kept closed until the fragment is reached to avoid damaging the soft tissues. Upon reaching the fragment, the jaws are used to grab it. Finally, the needle holder is removed with its jaws kept firmly shut, and the fragment is pulled alongside. Several attempts may be necessary. The technique is illustrated in **Fig. 4** and **Supplemental Video 5**.

RESULTS

Patients' demographics and procedures characteristics

From January 2012 to September 2020, a total of 3 529 patients (1225 males and 2304 females; mean age: 67.3 years) for a total of 7 139 cemented bones. One hundred and four patients (2.9%) underwent reinforced cementoplasty, 40 males and 64 females, mean age 61.6 years, for a total of 116 cemented bones. Three thousand four hundred and twenty-five patients (97.1%) underwent cementoplasty (1 185 males and 2 240 females, mean age 67.5 years), for a total of 7 023 cemented bones.

Detailed characteristics are displayed in **Supplemental Table 1**.

Spindle extraction / repositioning

Out of 104 patients (40 males and 64 females, mean age 61.6 years) who underwent reinforced cementoplasty, 6 (5.8%) presented with spindle malposition. All of them underwent spindle repositioning / extraction. The cases are described in **Table 1**. Two extractions (33%) were performed for an intra-/trans-articular spindle, 2 extractions (33%) were performed for an intra-muscular spindle, 1 extraction (17%) was performed for an intra-foraminal spindle, and 1 extraction (17%) was performed for a para-neurovascular spindle. All of them underwent spindle extraction or repositioning during the procedure, one requiring 2 different extraction techniques, leading to a total of 7 extraction attempts. Three attempts were made with the supple biopsy forceps technique, with 2 technical failures (success rate: 33%). Four attempts were made with the cementing technique, with no technical failure (success rate 100%). No complication related to the extraction techniques occurred.

Cement extraction

Out of 3 529 patients who underwent percutaneous cementoplasty or reinforced cementoplasty, for a total of 7 139 cemented bones, 1 130 (32%) presented with a cement leak in soft tissues. Out of those, 7 (0.6%) underwent cement extraction. The cases are described in **Table 2**. Indication for extraction was a cement leakage > 3cm in 3 cases (43%), a cement leakage in the oral cavity in 2 cases of transoral vertebroplasty (29%), a cement leakage reaching the skin in 1 case (14%), and 1 extraction (14%) was performed for a foraminal location in 1 case (14%). One patient had an elective extraction procedure after first unsuccessful attempt during the cementoplasty procedure. All other extractions were performed during the initial cementoplasty. Although all patients ultimately had a successful extraction, a total of 10 extraction attempts were necessary. Two attempts were made with the resheating technique, with 1 technical failure (50% success rate). Two attempts were made with the needle holder technique, with no technical failure (100% success rate). One unsuccessful attempt was made with the cementing technique described for spindle extraction (success rate 0%). Four attempts were made with the supple biopsy forceps technique, with 1 technical failure (75% success rate). One attempt was made with the manual extraction technique, with 0 technical failure (100% success rate). No major complication related to the extraction techniques occurred.

DISCUSSION

Our study evaluates the rate of cement leakage at 32%, the rate of spindle malposition at 5.8%, and presents several percutaneous techniques that can be used to extract or reposition a spindle, or extract a cement fragment located in the soft tissues. We showed that spindle malposition is not rare, as extraction was performed in 5.8% of reinforced cementoplasties. Cement leakages, while much more common, underwent an extraction attempt in 0.6% of cases.

Spindle malposition can lead to poor outcome depending on the location of the spindle. In the best-case scenario, the spindle will not provide the additional stability expected from a reinforced cementoplasty. In the worst cases, the spindle may damage important structures, such as cartilage, nerves or arteries with potential disastrous consequences. To the best of our knowledge, no previous study has estimated the prevalence of spindle malposition. The prevalence was 5.8% in our study. While uncommon, this issue was not rare either, and it is essential to learn techniques and strategies to fix it and avoid complications. A CBCT / CT scan should systematically be performed before cementing the spindle to confirm proper positioning, as both percutaneous and surgical extraction will be impossible after cementing. We provide herein several techniques to reposition or retrieve the spindle. Only one case ended with a technical failure, with a spindle positioned in the gluteus medius, probably leading the operator to be less aggressive in his attempt to extract the spindle compared to other cases. No complication related to the extraction attempt occurred in our series.

Soft tissue cement leakage is much more common, as described in the literature[5]. However, its clinical impact is uncertain. It is difficult to evaluate whether lingering pain after cementoplasty is related to cement leak, as it is not uncommon after a flawless cementoplasty with no leak, and not always present even with large cement leaks. The prevalence of cement leaks was evaluated in our study at 32%, meaning it is a common occurrence. Similarly, cement leakages have been reported in about 21% of the cases in the literature[5]. Despite the high incidence of these leakages, only 0.6% resulted in an extraction attempt in our study, with all cases leading to technical success. We suggest simple guidelines on when to attempt extraction: cement in soft tissues with a length > 3 cm or foraminal location or painful subcutaneous location. These guidelines are derived from our experience. However, to our knowledge, consensual indications are lacking in the literature. We described several techniques to perform the extraction of the cement with simple tools available in most angiosuites. No major complication related to the extraction procedures occurred. Of note, the extraction techniques we used may cause local pain, as they involve (re-)inserting and manipulating instruments in the paravertebral soft tissues. However, our study could not assess this additional pain since the extractions were performed during the same procedure as the cementoplasty/reinforced cementoplasty.

Our study suffers from several limitations: (i) its retrospective nature and reliance on saved fluoroscopic loops and operative report means that we may have missed some cases of cement/spindle extraction; (ii) extraction was performed at the operator's discretion, as there are no consensual, standardized guidelines on when to do it. While we believe the spindle extractions' indications to be rather consensual, for instance when the spindle is intra-articular, soft tissue cement fragment extraction is less consensual. Its clinical impact is unclear, with some being symptomatic while others are not; (iii) all procedures were performed in an expert institution so our results might not be generalizable to all centres; (iv) we did not evaluate the clinical outcome of the extraction, as all extractions but one were performed at the same time as the initial (reinforced) cementoplasty. Thus, the clinical impact of the extraction could not be assessed.

In summary, spindle malpositions and cement leaks during cementoplasties are not uncommon and may lead to treatment failure. Several percutaneous techniques may be safely and effectively used to retrieve such malpositioned spindles or cement leaks to improve patient outcome.

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FIGURE CAPTIONS

Figure 1

A 77-year-old female with unstable sacral fracture (asterisk) underwent reinforced sacroplasty. (A) Control CT after spindle insertion showed malposition, with the spindle's tip (arrow) in the S2 foramen (arrowhead). (B) The spindle proximal aspect was catheterized using the 8G bone needle. (C) A supple biopsy forceps was then inserted in the bone needle's lumen and used to grab the spindle. (D) After pulling on the biopsy forceps, the spindle moved back and was no longer in conflict with the S2 nerve root. (E) Control CT-scan showed that the spindle was properly positioned. (F) Post-procedural CT-scan showed satisfactory results, with no foreign body inside the foramen (arrowhead).

Figure 2

(A) A 65-year-old male with large iliac metastasis (asterisk) with osteolysis (arrow) underwent reinforced cementoplasty. (B) The malpositioned spindle was catheterized using the 8G bone needle. (C) The bone needle was advanced further so that the whole spindle was inside the bone needle's lumen. (D) Bone cement was injected inside the lumen, around the spindle, with no bone cement exiting the bone needle's lumen. (E) Upon cement hardening, the bone needle was pulled, and the spindle was removed alongside the bone needle. (F) Final control showed only the lower, properly positioned spindle remained.

Figure 3

A 68-year-old female with osteoporotic vertebral fractures underwent T6, T11, T12 and L2 vertebroplasty and L1 vertebral expansion. (A) During bone needle withdrawal, a 3 cm cement cylinder leaked in para-vertebral soft tissues (arrowhead). (B) The cement cylinder was catheterized under fluoroscopy with a 11G bone needle. (C) The cylinder was bent until it broke and detached from the cement within the vertebra. (D) Final control showed no cement remained in soft tissues at the level cement extraction was performed.

Figure 4

A 64-year-old male with a symptomatic osteoporotic sacral fracture underwent sacroplasty. (A) During needle withdrawal, a 3 cm cement fragment leaked in the gluteus medius and subcutaneous tissue (white arrowhead). (B) In the following days, the patient suffered from local pain related to the foreign body (white arrowhead). (C) A needle holder (black arrow) was inserted through a small incision and advanced under fluoroscopy toward the cement fragment (white arrowhead). (D) After extracting the cement fragment with the needle holder, no cement remained outside the iliac bone.

TABLE CAPTIONS

Table 1 – Spindle extraction cases

Description of all spindle extraction cases performed in our study population. Two attempts have been made for 1 patient.

Table 2 – Cement extraction cases

Description of all cement extraction cases performed in our study population. Multiple attempts have been made for 2 patients.