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Serial Radiographic Appearance of Cerament Bone Graft Substitute in Various Orthopedic Surgery Applications

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Background:

Bone graft material comes in the form of autograft and allograft bone tissue as well as bone graft substitute and is used to treat a variety of bone void filling and dead-space management issues in orthopaedics, neurosurgery, and dentistry. CERAMENT BONE VOID FILLER (CBVF; BONESUPPORT AB, Lund, Sweden) is a biphasic synthetic bone graft substitute that combines resorbable calcium sulfate (60%) with hydroxyapatite (40%) and iohexol contrast for radiographic visibility. As the use of CBVF becomes more common across a variety of indications, recognition and interpretation of the material's imaging appearance will prove vital to radiologists and surgeons involved in follow up care of patients with this graft material.

Questions/Purposes:

This study aims to analyze the post-operative radiographic appearance of CBVF over time in a variety of orthopedic surgery applications through the following study questions: 1) What is the time to post-operative radiographic imperceptibility of the CBVF material? 2) Does time to radiographic imperceptibility vary by surgical indication? 3) What post-operative radiographic morphologies characterize the CBVF during resorption and remodeling?

Patients and Methods:

This retrospective study received IRB approval. The electronic medical record identified all surgical cases using CBVF with at least 12 months of post-operative radiographs available. Cases where the CBVF material could not be definitively identified on the first postoperative radiographs were excluded. Clinical and surgical details were recorded. Patient radiographs were reviewed in consensus by the authors. Radiographs were analyzed for visibility, size, and relative density of the CBVF material. In addition, the morphology of CBVF material density was characterized.

Results:

Our search identified 19 cases in 18 patients fitting our study criteria. Surgeries were performed between 2016 and 2020 and included: arthroplasties (10 cases), bone tumor surgeries (6 cases) and osteonecrosis surgeries (3 cases). The patient population consisted of 12 women and 6 men with an average patient age of 46 years (range 15 – 71 years). Radiographic analysis showed that in all cases the CBVF progressively decreased in density over time and, when visible, was higher in density than surrounding trabecular bone. In 16 of the 19 cases, the CBVF became imperceptible radiographically at an average time of 7.6 months (SD 5.6 months) **(Figure 1).** Stratified by surgical indication (arthroplasty, AVN, tumor), there was no difference in mean post-operative time to radiographic imperceptibility (6.7, 9.9, 7.8 months, respectively; $p = 0.73$). The CBVF morphologies visible radiographically were categorized as: no specific pattern (60%), puddle pattern (19%), halo pattern (10.5%), and marble pattern (10.5%) **(Figure 2).**

Three cases did not achieve radiological imperceptibility within the follow-up period. Two arthroplasty cases, one proximal tibia and one proximal femur, had CBVF visible on radiographs at 13mo and 21mo follow-up, respectively. One tumor case with a humeral lesion had CBVF visible on radiographs at 12mo follow-up. Similar to the rest of the study cases, these three cases demonstrated the CBVF to progressively decrease in density throughout every radiographic sequence including when comparing the penultimate and final follow-up radiographs.

Conclusion:

CBVF is a radiographically visible synthetic bone graft substitute used in various orthopedic surgeries. A relatively unique feature of this material is its progressive decrease in radiographic density over time. In our study cohort, the average time to radiographic imperceptibility was 7.6 months for 16 of our 19 cases. This sequential decrease in radiographic density is important to recognize because loss of density at an operative site where CBVF has been used does not necessarily indicate a new osteolytic process and can be viewed as an expected physiologic evolution of the material. This trend in our study was consistent with the wider literature, and therefore, any increasing density on serial radiographs at a CBVF graft site should be viewed with suspicion of an osteoblastic process. As CBVF continues to increase in clinical use, radiologists and orthopaedic surgeons involved with bone imaging should be familiar with this material and recognize its expected radiographic decrease in density over time.

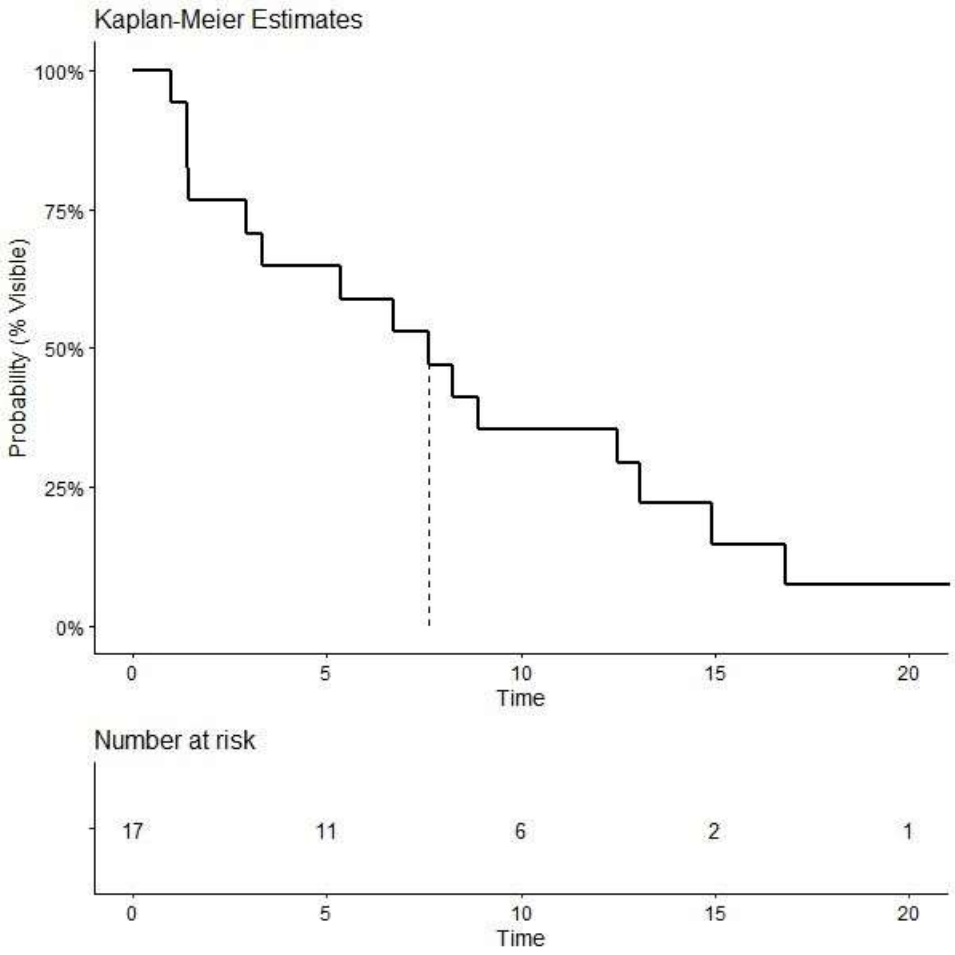

Figure 1 Kaplan-Meier estimates for overall percent radiographic visibility.

Figure 2 CBVF radiographic morphologic features

a) Halo sign (black arrowheads) for CBVF placed in a hamate aneurysmal bone cyst,

b) Marble sign (white arrowheads) in a trochanteric defect, CBVF augments the femoral component of a total hip arthroplasty.

c) Puddle sing with CBVF augmenting the tibial component of a total knee arthroplasty

d) No specific pattern in CBVF used in a plated long bone fracture.