Cement volume is the most important modifiable predictor for pain relief in BKP: results from SWISSspine, a nationwide registry

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PURPOSE
The effectiveness of vertebral augmentation techniques is a currently highly debated issue. The biomechanical literature suggests that cement filling volumes may play an important role in the "dosage" of vertebral augmentation and its pain alleviating effect. Good clinical data about filling volumes are scarce and most patient series are small. Therefore, we investigated the predictors of pain alleviation after balloon kyphoplasty in the nationwide SWISSspine registry where cement volumes are also recorded.

METHODS
All single-level vertebral fractures with no additional fracture stabilization and availability of at least one follow-up within 6 months after surgery were included. The following potential predictors were assessed in a multivariate logistic regression model with the group's average pain alleviation of 41 points on VAS as the desired outcome: patient age, patient sex, diagnosis, preoperative pain, level of fracture, type of fracture, age of fracture, segmental kyphotic deformity, cement volume, vertebral body filling volume, and cement extrusions.

RESULTS
There were 194 female and 82 males with an average age of 70.4 and 65.3 years, respectively. Female patients were about twice as likely for achieving the average pain relief compared to males (p = 0.04). The preoperative pain level was the strongest predictor in that the likelihood for achieving an at least 41-point pain relief increased by about 8 % with each additional point of preoperative pain (p < 0.001). A thoraco-lumbar fracture had a three times higher odds for the average pain relief compared with a lumbar fracture (p = 0.03). An A.3.1 fracture only had about a third of the probability for average pain relief compared with an A.1.1 fracture (p = 0.004). Cement volumes up to 4.5 ml only had an approximately 40 % chance for a minimum 41-point pain alleviation as compared with cement volumes of at least 4.5 ml (p = 0.007). In addition, the relationship between cement volume and pain alleviation followed a dose-dependent pattern.
CONCLUSIONS
Cement volume was revealed as a significant predictor for pain relief in BKP. Cement volume was the third most important influential covariate and the most important modifiable and operator dependent one. The clear dose-outcome relationship between cement filling volumes and pain relief additionally supports these findings. Cement volumes of >4.5 ml seem to be recommendable for achieving relevant pain alleviation. Patient sex and fracture type and location were further significant predictors and all these covariates should be recorded and reported in future studies about the pain alleviating effectiveness of vertebral augmentation procedures.

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