Hemorrhage is a frequent complication of post myocardial infarction (MI) patients receiving percutaneous coronary intervention reperfusion therapy and is independently associated with post-operative adverse clinical outcomes such as impaired left ventricular (LV) remodeling, fatal arrythmias, and heart failure. Current relaxation time magnetic resonance (MR) imaging techniques are used to identify hemorrhage but are influenced by other confounding factors of inflammation such as edema and fibrosis. We use magnetic resonance quantitative susceptibility mapping (QSM) to detect hemorrhage in a large animal model of MI, where iron is the magnetically susceptible biomarker. The reconstruction of susceptibility maps utilizes MR phase images to solve an ill-posed inverse problem requiring regularization and weighting of single orientation acquired images. The gold standard QSM technique known as calculation of susceptibility through multiple orientation sampling (COSMOS) avoids the ill-posed nature of QSM reconstruction by creating an overdetermined system through imaging a patient or phantom at multiple orientations. To validate our single orientation QSM reconstruction algorithm, it is presented here the steps taken to generate susceptibility maps using COSMOS, the results of the algorithm, and the algorithm’s ultimate role in the project’s aim to accurately quantify hemorrhage in post-MI patients.