3D X-ray tomography recordings have been used to study graphite growth during solidification of ductile cast iron. Using data from such recordings, it is shown how local growth conditions influence growth rate and morphology of nodules during solidification. Experiments show that it is common for nodules to gradually change shape during solidification so that sphericity decreases. It is also found that different shaped nodules can evolve in direct contact with liquid iron and also after they are encapsulated in austenite. It is observed that a significant proportion of originally complete spherical nodules become less spherical via formation of protrusions on the surface; these new surfaces are observed to grow relatively faster. It is shown that encapsulation of the graphite nodule by austenite may be incomplete and that at the end of solidification, partial encapsulation and the effect of the number of nearest graphite nodules play a crucial role in determining the final graphite morphology.