Three-dimensional imaging and interpretation

Clinical Policy ID: CCP.1389

Recent review date: 11/2025

Next review date: 3/2027

Policy contains: Endoscopy; three-dimensional rendering or reconstruction; tomography; ultrasonography.

Coverage policy

Three-dimensional imaging (also called three-dimensional reconstruction or rendering), interpretation, and reporting are clinically proven and, therefore, may be medically necessary when all of the following criteria are met (American Association of Endodontists/American Academy of Oral and Maxillofacial Radiology, 2015; Dong, 2025; Plana, 2014; Simpson, 2017; Tang, 2025; Virani, 2016):

- The additional imaging detail will impact the diagnosis or clinical course of the member.
- The service is consistent with accepted standards of medical practice.
- Sufficient clinical expertise is available to perform the procedure and interpret the results.
- A written order or referral documents the medical necessity for the additional three-dimensional imaging.
- The interpreting physician's report addresses the medical necessity identified by the ordering or referring health care provider.

Limitations

The interpreting physician shall maintain a copy of the test results and interpretation along with a copy of the ordering or referring health care provider's order for the study.

The use of three-dimensional imaging, interpretation, and reporting is investigational/not clinically proven and, therefore, not medically necessary when any of the following conditions are present:

- Equivalent information obtained from the test has already been provided by another procedure (such as ultrasound, magnetic resonance imaging, or angiography).
- Equivalent information obtained from the test could be provided by a standard (two-dimensional) imaging study without reconstruction.
- The procedure is performed routinely based on the internal protocols of the testing facility.
- The procedure is not consistent with accepted standards of medical practice.
- Documentation of medical necessity is lacking.

Alternative covered services

Standard of care patient evaluation and management by a network health care provider.

Background

The majority of medical imaging is presented as two-dimensional information. Advances in multi-detector computed tomographic imaging capture large volumes of information in digital form, which, in turn, allows data to be manipulated into other planes that were not acquired directly during the acquisition. Multidetector tomographic modalities (e.g., computed tomography, magnetic resonance tomography, and positron-emission tomography) and ultrasonography can create three-dimensional depictions of morphologic and physiological attributes characteristic of health and disease (Sarmah, 2023).

Many techniques may be used to produce and store three-dimensional imaging and improve the understanding of a pathological process. Pre-image processing is essential for clearing extraneous data and accurately depicting tissues and organs. It may require specialized algorithms for processing. Three-dimensional reconstruction is expensive, and its use is confined to specially designed medical devices that can accommodate higher-resolution images (Sarma, 2023).

Findings

Guidelines

A number of guidelines support three-dimensional imaging, when the additional information will impact diagnosis or treatment planning and when sufficient expertise is available to perform the procedure and interpret the results. Three-dimensional rendering and reconstruction represent important technological advancements that capture more anatomically accurate data sets and, in turn, provide additional detail and a dimension of depth of anatomy and pathology not found with standard two-dimensional modalities. Three-dimensional imaging can be justified on an individual basis based on clinical presentation taking into account specific use, optimization protocols, radiation dose, risk-assessment strategies, and current standards of practice (American Association of Endodontists/American Academy of Oral and Maxillofacial Radiology, 2015; Dong, 2025; Plana, 2014; Simpson, 2017; Tang, 2025; U.S. Preventive Services Task Force, 2024; Virani, 2016).

Evidence review

Low- to moderate-quality evidence from systematic reviews and meta-analyses demonstrates comparable to superior aspects of diagnostic accuracy of three-dimensional imaging versus two-dimensional imaging for many clinical applications. However, the impact of these technological advancements on diagnostic certainty, treatment planning, and clinical outcomes has not been quantified, and the clinical or cost effectiveness compared to less expensive and more readily available alternatives has not been established, lending ambiguity to the optimal choice of imaging. The intended clinical application will determine the degree of accuracy and precision required, along with the desire to reduce radiation exposure. The incremental value of three-dimensional imaging over current imaging standards for many indications has not been determined, and justification for the additional information would be needed.

Several systematic reviews and meta-analyses have examined a range of clinical uses for three-dimensional imaging methods. Clinical applications include, but are not limited to:

- Assessment and treatment planning in craniofacial surgery (Werathammo, 2025).
- Assessment and treatment planning in dentistry and oral surgery (Awarun, 2019; Chen, 2021; Erum, 2025; Hartmann, 2019; Saini, 2025; Thierens, 2018; Wismeijer, 2018).
- Assessment and treatment planning in liver surgery (Banchini, 2024).
- Assessment and treatment planning in orthopedic surgery (Boudissa, 2024; Kosy, 2018; Kwan, 2025; Liu, 2025; Nevalainen, 2025; Suri, 2025).
- Breast cancer detection (specifically ultrasonography) (Bin, 2019).
- Detection of soft tissue defects of the knee (Shakoor, 2018) and rotator cuff (Teng, 2018).
- Diagnosis and classification of uterine abnormalities (Spagnol, 2022; Xydias, 2025).
- Facilitation of laparoscopic and thoracoscopic surgeries (Fergo, 2017; Liang, 2018; Sánchez-Margallo, 2021; Vettoretto, 2018).
- Guiding brachytherapy for cervical cancer (Kim, 2020).
- Guiding tubal sterilization microinsert positioning (Carretti, 2019).

In 2019, we updated the references and added several new systematic reviews and meta-analyses with no policy changes warranted.

In 2020, we updated the reference list. No policy changes are warranted.

In 2021, we updated the references with no policy changes warranted.

In 2022, we updated the reference list. No policy changes are warranted.

In 2023, we identified no newly published, relevant literature to add to the policy.

In 2024, we updated the references with no policy changes warranted.

In 2025, we reorganized the findings and updated the references with no policy changes.

References

On September 16, 2025, we searched PubMed and the databases of the Cochrane Library, the U.K. National Health Services Centre for Reviews and Dissemination, the Agency for Healthcare Research and Quality, and the Centers for Medicare & Medicaid Services. Search terms were “Imaging, Three-Dimensional” (MeSH), “three-dimensional imaging,” “three-dimensional rendering,” and “three-dimensional reconstruction.” We included the best available evidence according to established evidence hierarchies (typically systematic reviews, meta-analyses, and full economic analyses, where available) and professional guidelines based on such evidence and clinical expertise.

American Association of Endodontists/American Academy of Oral and Maxillofacial Radiology. Position statement. Use of cone beam computed tomography in endodontics. https://www.beamreaders.com/hubfs/aae%20aaomr%202016%20update.pdf. Published 2010. Updated 2015.

Awarun B, Blok J, Pauwels R, Politis C, Jacobs R. Three-dimensional imaging methods to quantify soft and hard tissues change after cleft-related treatment during growth in patients with cleft lip and/or cleft palate: A systematic review. *Dentomaxillofac Radiol.* 2019;48(2):20180084. Doi: 10.1259/dmfr.20180084.

Banchini F, Capelli P, Hasnaoui A, Palmieri G, Romboli A, Giuffrida M. 3-D reconstruction in liver surgery: A systematic review. *HPB (Oxford)*. 2024;26(10):1205-1215. Doi: 10.1016/j.hpb.2024.06.006.

Bin L, Huihui Y, Weiping Y, et al. Value of three-dimensional ultrasound in differentiating malignant from benign breast tumors: A systematic review and meta-analysis. *Ultrasound Q.* 2019;35(1):68-73. Doi: 10.1097/ruq.0000000000000433.

Boudissa M, Khoury G, Franke J, Gänsslen A, Tonetti J. Navigation and 3d-imaging in pelvic ring surgery: A systematic review of prospective comparative studies. *Arch Orthop Trauma Surg*. 2024;144(10):4549-4559. Doi: 10.1007/s00402-024-05468-2.

Carretti M, Dos Santos Simoes R, Bernardo WM, et al. Accuracy of ultrasonography in the evaluation of tubal sterilization microinsert positioning: Systematic review and meta-analysis. *J Ultrasound Med.* 2019;38(2):289-297. Doi: 10.1002/jum.14714.

Chen Z, Mo S, Fan X, et al. A meta-analysis and systematic review comparing the effectiveness of traditional and virtual surgical planning for orthognathic surgery: Based on randomized clinical trials. *J Oral Maxillofac Surg.* 2021;79(2):471.e471-471.e419. Doi: 10.1016/j.joms.2020.09.005.

Dong Q, Xiu W, Tang B, et al. International multidisciplinary consensus recommendations on clinical application of three-dimensional visualization in precision surgery for pediatric liver tumors. *HPB (Oxford)*. 2025;27(6):733-745. Doi: 10.1016/j.hpb.2025.03.007.

Erum GE, Haghighi P, Cunningham J, Stevens K. Three-dimensional assessment of outcomes of surgical midface advancement in syndromic craniosynostosis: A systematic review. *J Craniomaxillofac Surg*. 2025;53(8):1167-1175. Doi: 10.1016/j.jcms.2025.04.013.

Fergo C, Burcharth J, Pommergaard HC, Kildebro N, Rosenberg J. Three-dimensional laparoscopy vs 2-dimensional laparoscopy with high-definition technology for abdominal surgery: A systematic review. *Am J Surg.* 2017;213(1):159-170. Doi: 10.1016/j.amjsurg.2016.07.030.

Hartmann RC, Fensterseifer M, Peters OA, et al. Methods for measurement of root canal curvature: A systematic and critical review. *Int Endod J.* 2019;52(2):169-180. Doi: 10.1111/iej.12996.

Kim YJ, Kang HC, Kim YS. Impact of intracavitary brachytherapy technique (2D versus 3D) on outcomes of cervical cancer: A systematic review and meta-analysis. *Strahlenther Onkol.* 2020;196(11):973-982. Doi: 10.1007/s00066-020-01658-0.

Kosy JD, Mandalia VI. Plain radiographs can be used for routine assessment of ACL reconstruction tunnel position with three-dimensional imaging reserved for research and revision surgery. *Knee Surg Sports Traumatol Arthrosc.* 2018;26(2):534-549. Doi: 10.1007/s00167-017-4462-5.

Kwan CK, Young JH, Lai JC, et al. Three-dimensional (3D) ultrasound imaging for quantitative assessment of frontal Cobb angles in patients with idiopathic scoliosis - a systematic review and meta-analysis. *BMC Musculoskelet Disord*. 2025;26(1):222. Doi: 10.1186/s12891-025-08467-5.

Liang H, Liang W, Lei Z, et al. Three-dimensional versus two-dimensional video-assisted endoscopic surgery: A meta-analysis of clinical data. *World J Surg.* 2018;42(11):3658-3668. Doi: 10.1007/s00268-018-4681-z.

Liu G, Huang C, Li Y, et al. Accuracy and consistency of 3-dimensional magnetic resonance imaging is comparable with 3-dimensional computed tomography in assessing glenohumeral instability: A systematic review. *Arthroscopy*. 2025;41(4):1072-1084.e5. Doi: 10.1016/j.arthro.2024.03.043.

Nevalainen MT, Vähä J, Räsänen L, Bode MK. Diagnostic utility of 3D MRI sequences in the assessment of central, recess and foraminal stenoses of the spine: A systematic review. *Skeletal Radiol*. 2024;53(12):2575-2584. Doi: 10.1007/s00256-024-04689-1.

Plana JC, Galderisi M, Barac A, et al. Expert consensus for multimodality imaging evaluation of adult patients during and after cancer therapy: A report from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. *J Am Soc Echocardiogr.* 2014;27(9):911-939. Doi: 10.1016/j.echo.2014.07.012.

Saini RS, Vaddamanu SK, Kanji MA, Mosaddad SA, Heboyan A. Comparative analysis of 3D imaging in periodontal disease assessment: A systematic review and meta-analysis. *Clin Exp Dent Res*. 2025;11(4):e70169. Doi: 10.1002/cre2.70169.

Sánchez-Margallo FM, Durán Rey D, Serrano Pascual Á, Mayol Martínez JA, Sánchez-Margallo JA. Comparative study of the influence of three-dimensional versus two-dimensional urological laparoscopy on surgeons' surgical performance and ergonomics: A systematic review and meta-analysis. *J Endourol.* 2021;35(2):123-137. Doi: 10.1089/end.2020.0284.

Sarmah M, Neelima A, Singh HR. Survey of methods and principles in three-dimensional reconstruction from two-dimensional medical images. *Vis Comput Ind Biomed Art*. 2023;6(1):15. Doi: 10.1186/s42492-023-00142-7.

Shakoor D, Guermazi A, Kijowski R, et al. Diagnostic performance of three-dimensional MRI for depicting cartilage defects in the knee: A meta-analysis. *Radiology.* 2018;289(1):71-82. Doi: 10.1148/radiol.2018180426.

Simpson J, Lopez L, Acar P, et al. Three-dimensional echocardiography in congenital heart disease: An expert consensus document from the European Association of Cardiovascular Imaging and the American Society of Echocardiography. *J Am Soc Echocardiogr.* 2017;30(1):1-27. Doi: 10.1016/j.echo.2016.08.022.

Spagnol G, Noventa M, Bonaldo G, et al. Three-dimensional transvaginal ultrasound vs magnetic resonance imaging for preoperative staging of deep myometrial and cervical invasion in patients with endometrial cancer: Systematic review and meta-analysis. *Ultrasound Obstet Gynecol*. 2022;60(5):604-611. Doi: 10.1002/uog.24967.

Suri I, Ezzat B, Suthakaran S, et al. Systematic review of surgical success, complications, revision rates, radiation dosage, and operative time of 3D-navigated versus non-navigated spinal procedures. *World Neurosurg*. 2025;194:123550. Doi: 10.1016/j.wneu.2024.12.009.

Tang GHL, Zaid S, Hahn RT, et al. Structural heart imaging using 3-dimensional intracardiac echocardiography: JACC: Cardiovascular imaging position statement. *JACC Cardiovasc Imaging*. 2025;18(1):93-115. Doi: 10.1016/j.jcmg.2024.05.012.

Teng A, Liu F, Zhou D, et al. Effectiveness of 3-dimensional shoulder ultrasound in the diagnosis of rotator cuff tears: A meta-analysis. *Medicine (Baltimore).* 2018;97(37):e12405. Doi: 10.1097/md.0000000000012405.

Thierens LAM, De Roo NMC, De Pauw GAM, Brusselaers N. Assessment modalities of non-ionizing three-dimensional images for the quantification of facial morphology, symmetry, and appearance in cleft lip and palate: A systematic review. *Int J Oral Maxillofac Surg.* 2018;47(9):1095-1105. Doi: 10.1016/j.ijom.2018.05.017.

U.S. Preventive Services Task Force. Final recommendation statement: Breast cancer: Screening. https://www.uspreventiveservicestaskforce.org/Page/Document/RecommendationStatementFinal/breast-cancer-screening1. Published April 20, 2024.

Vettoretto N, Reggiani L, Cirocchi R, et al. Three-dimensional versus two-dimensional laparoscopic right colectomy: A systematic review and meta-analysis. *Int J Colorectal Dis.* 2018;33(12):1799-1801. Doi: 10.1007/s00384-018-3121-8.

Virani SA, Dent S, Brezden-Masley C, et al. Canadian Cardiovascular Society guidelines for evaluation and management of cardiovascular complications of cancer therapy. *Can J Cardiol.* 2016;32(7):831-841. Doi: 10.1016/j.cjca.2016.02.078.

Werathammo M, Seresirikachorn K, Charoenlux P. Unveiling the impact of three-dimensional technology on rhinoplasty: A systematic review and meta-analysis. *Facial Plast Surg*. 2025;41(3):401-409. Doi: 10.1055/a-2370-2125.

Wismeijer D, Joda T, Flugge T, et al. Group 5 ITI consensus report: Digital technologies. *Clin Oral Implants Res.* 2018;29 Suppl 16:436-442. Doi: 10.1111/clr.13309.

Xydias EM, Liasidi PN, Papageorgouli D, et al. Three-dimensional transvaginal ultrasound versus MRI in the diagnosis and classification of congenital uterine anomalies: A systematic review and meta-analysis. *Eur J Obstet Gynecol Reprod Biol*. 2025;312:114560. Doi: 10.1016/j.ejogrb.2025.114560.

Policy updates

6/2018: initial review date and clinical policy effective date: 10/2018

10/2019: Policy references updated.

10/2020: Policy references updated.

10/2021: Policy references updated.

11/2022: Policy references updated.

11/2023: Policy references updated.

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