author	year	number of hips	age (years) mean (range)	cadaver included	DDH hips	Crowe	normal hips	FAI	modality	frame	consideration for femoral head	global orientation: vector	triplanar measurement	acetabular segmentation	Femoral coverage surface
Abel et al. (1)	1994	1	NR	Y	N		N	N	CT	APP	N	N	A	N	N
Agten et al. (2)	2017	18	NR	Y	N		N	N	CT	APP	N	N	N	A	N
Akiyama et al. (3)	2011	62	30	N	Y	1	Y	N	MRI	NRP	Y	N	F	N	N
Archbold et al. (4)	2008	25	28 (17;43)	N	N		Y	N	MRI	APP	N	R	N	N	N
Armand et al. (5)	2005	12	NR (20;50)	N	Y	NR	N	N	CT	NRP	Y	N	A/S/F	N	N
Armiger et al. (6)	2009	12	NR (20;51)	N	Y	NR	N	N	CT	NRP	Y	N	N	N	N
Bouma et al. (7)	2015	5	NR	N	N		Y	Y	CT	STC	Y	N	N	C	Y
Bouma et al. (8)	2014	55	45 (29;71)	N	N		Y	Y	CT	STC	Y	N	N	C	Y
Caffrey et al. (9)	2019	14	NR (3;7)	N	Y	NR	N	N	CT	APP	N	R	N	C	N
Cai et al. (10)	2018	372	3 (1;6)	N	Y	NR	Y	N	CT	APP	N	N	A	N	N
Cerveri et al. (11)	2011	30	77 (56;95)	Y	N		N	N	CT	NRP	N	R	N	N	N
Chang et al. (12)	2011	60	7 (4;10)	N	Y	1,2	Y	N	CT	APP	N	N	N	C	N
Cheng et al. (13)	2019	135	57	N	Y	1,2,3	Y	N	CT	APP	Y	N	N	N	N
Chung et al. (14)	2006	54	8	N	Y	NR	Y	N	CT	NRP	N	N	N	C	N
Dandachli et al. (15)	2008	75	29 (14;61)	N	Y	NR	Y	N	CT	APP	Y	R	N	N	Y
Dandachli et al. (16)	2012	31	51 (16;81)	N	N		Y	Y	CT	APP	Y	R	S/F	N	Y
Dandachli et al. (17)	2006	34	NR	N	N		Y	N	CT	STC/APP	N	R	N	N	N
Dandachli et al. (18)	2011	34	27 (19;45)	N	N		N	Y	CT	APP	N	R	N	A	N
Durand-Hill et al. (19)	2016	11	NR	N	Y	NR	Y	N	CT	APP	N	N	N	N	N
Falliner et al. (20)	2002	6	NR (0;0,5)	Y	N		Y	N	MRI	NRP	N	N	A/F	N	N
Fujii et al. (21)	2011	122	51 (17;75)	N	Y	1	Y	N	CT	APP	Y	N	A/F	N	N
Gillard et al. (22)	2013	24	NR	Y	N		N	N	other	NRP	N	N	N	N	N
Gose et al. (23)	2009	150	5 (3;7)	N	Y	NR	N	N	CT	STC	Y	S	N	N	N
Gu et al. (24)	2008	25	45 (29;65)	Y	N		Y	N	other	STC	N	N	N	N	N

Ha et al. (25)	2012	50	54 (19;78)	N	N		N	N	CT	NRP	Y	N	A/F	N	N
Haimerl et al. (26)	2012	420	NR	Y	N		N	N	CT	APP	N	N	N	N	N
Hamada et al. (27)	2018	52	33 (16;48)	N	Y	1	N	N	CT	NRP	Y	N	A/F/S	C	N
Hansen et al. (28)	2012	34	NR	N	N		Y	N	CT	NRP	Y	N	N	N	Y
Harrington et al. (29)	2007	64	NR (5;40)	N	N		Y	N	MRI	STC	Y	N	N	N	N
Hashemi et al. (30)	2017	500	51 (18;98)	N	N		N	N	CT	APP	N	R	N	N	N
Hausselle et al. (31)	2012	14	NR	Y	N		N	N	other	APP	N	N	N	N	N
Hayashi et al. (32)	2020	71	33 (16;50)	N	Y	NR	N	N	CT	NRP	Y	N	F	S	N
Hayashi et al. (33)	2013	6	51 (49;52)	Y	Y	NR	N	N	CT	APP	N	N	N	N	N
Herman et al. (34)	2021	124	NR (10;18)	N	N		Y	N	CT	NRP	Y	N	N	C	N
Hettich et al. (35)	2019	136	NR	N	N		N	N	CT	APP	N	R	N	C	N
Imai et al. (36)	2019	168	35 (20;52)	N	Y	1	N	N	CT	APP	Y	N	A/F/S	N	N
Irie et al. (37)	2020	115	40 (16;60)	N	Y	NR	Y	N	CT	NRP	Y	N	A/F	C	N
Irie et al. (38)	2020	115	40 (16;60)	N	Y	NR	Y	N	CT	NRP	Y	N	A/F	C	N
Irie et al. (39)	2020	113	40 (16;60)	N	Y	NR	Y	N	CT	NRP	Y	N	A/F	C	N
Ito et al. (40)	2009	84	35 (15;64)	N	Y	1	N	N	CT	NRP	Y	N	A/F/S	N	N
Janzen et al. (41)	1998	15	34 (19;49)	N	N		Y	N	CT	NRP	Y	N	N	C	N
Jia et al. (42)	2012	124	2 (1;4)	N	Y	1	N	N	CT	NRP	Y	N	A/F	N	N
Jia et al. (43)	2011	242	2 (1;5)	N	Y	1	Y	N	CT	NRP	N	N	A	N	N
Jóźwiak et al. (44)	2015	60	NR	N	N		N	N	CT	APP/STC/SB	N	CP	A	N	N
Jóźwiak et al. (45)	2021	58	13 (9;16)	Y	Y	2,3,4	Y	N	CT	SB	N	CP	N	N	N
Kamenaga et al. (46)	2020	30	31 (20;49)	N	Y	NR	N	N	CT	NRP	Y	N	F/S	C	N
Karami et al. (47)	2010	5	NR	N	Y	NR	N	N	CT	NRP	Y	N	N	F	N
Kim et al. (48)	2021	200	NR (25;39)	N	N		Y	N	CT	APP	N	R	N	N	N
Kohno et al. (49)	2020	93	38 (13;59)	N	Y	1	N	N	CT	APP	Y	N	N	A	Y

Kohno et al. (50)	2016	92	50 (15;87)	N	Y	1	Y	N	CT	APP	Y	N	N	C	N
Larson et al. (51)	2015	409	25 (20;35)	N	N		Y	N	CT	APP	Y	N	N	C	Y
Lee et al. (52)	2019	400	62 (17;91)	N	N		Y	N	CT	APP	N	R	N	N	N
Legaye et al. (53)	2011	110	NR (18;NR)	Y	N		N	N	CT	APP	N	S	N	N	N
Liu et al. (54)	2014	10	NR	Y	N		N	N	CT	APP	Y	R	F	N	Y
Liu et al. (55)	2015	4	NR	N	Y	NR	N	N	CT	APP	Y	R	F	N	N
Lubovsky et al. (56)	2010	50	43 (20;63)	N	N		Y	N	CT	APP	N	R	N	N	N
Lubovsky et al. (57)	2012	76	69 (NR)	N	N		Y	N	CT	APP	N	R	N	N	N
Mascarenhas et al. (58)	2018	1111	33 (14;45)	N	N		Y	Y	CT	APP	Y	N	A/F	C	Y
Mascarenhas et al. (59)	2018	548	34 (18;50)	N	N		Y	Y	MRI	APP	N	N	A/F	A/C	Y
Miyasaka et al. (60)	2014	74	51 (18;69)	N	Y	NR	Y	N	CT	APP	Y	N	A/F/S	N	N
Miyasaka et al. (61)	2017	240	46 (11;87)	N	N		Y	N	CT	APP	Y	N	A/F/S	N	N
Murtha et al. (62)	2008	42	56 (37;79)	N	N		Y	N	CT	APP	Y	R	N	N	N
Musielak et al. (63)	2016	62	NR	N	N		Y	N	CT	SB	N	CP	N	N	N
Musielak et al. (64)	2016	100	56 (NR)	N	N		Y	N	CT	SB	N	CP	N	N	N
Nakahara et al. (65)	2011	106	72 (NR)	N	Y	NR	N	Y	CT	APP	Y	N	A/F	C	N
Nakamura et al. (66)	2000	38	40 (16;78)	N	Y	NR	Y	N	CT	NRP	Y	N	A	N	Y
Nardi et al. (67)	2021	52	NR	N	N		N	Y	MRI	NRP	Y	N	A/F	N	N
Needell et al. (68)	2014	38	36 (15;60)	N	Y	NR	N	N	CT	APP	Y	N	S	N	N
Nepple et al. (69)	2017	50	26 (13;49)	N	Y	NR	N	N	CT	NRP	Y	N	F	C	N
Osmani et al. (70)	2013	65	70 (42;91)	N	N		Y	N	CT	APP	N	R	N	N	N
Park et al. (71)	2017	96	NR (40;NR)	N	N		N	N	CT	APP	N	R, S	A/F	N	N
Park et al. (72)	2019	240	47 (38;66)	N	N		Y	N	CT	APP	N	N	N	A/ F	N
Perreira et al. (73)	2011	100	39 (16;62)	N	N		Y	N	CT	APP	N	N	N	A	N
Peterson et al. (74)	2015	314	NR (8;17)	N	N		Y	N	CT	NRP	N	S	N	C	N

Puls et al. (75)	2011	10	NR	N	N		Y	N	CT	APP	N	R	N	N	N
Rasquinha et al. (76)	2012	26	40 (NR)	N	Y	NR	Y	N	CT	APP	N	N	N	N	N
Sakai et al. (77)	2009	100	36 (15;59)	N	Y	NR	Y	N	CT	STC	Y	N	F/S	N	N
Sautet et al. (78)	2018	300	65 (15;95)	N	N		Y	N	CT	APP	N	S	N	N	N
Suh et al. (79)	2012	21	39 (15;84)	N	Y	NR	Y	N	CT	NRP	Y	N	N	C	N
Suzuki et al. (80)	2017	240	48 (15;79)	N	N		Y	N	CT	APP	Y	N	A/F/S	N	N
Tanaka et al. (81)	2021	53	61 (36;69)	N	Y	NR	Y	N	CT	NRP	Y	N	A	N	N
Tanaka et al. (82)	2018	40	51 (17;68)	N	Y	NR	Y	N	CT	APP	Y	N	F/S	N	Y
Uemura et al. (83)	2021	22	23 (NR)	N	N		Y	N	CT	APP	Y	N	N	C	Y
Upasani et al. (84)	2020	324	NR (8;19)	N	N		Y	N	CT	APP	N	S	N	C	N
Van Bosse et al. (85)	2011	2	NR	Y	N		Y	N	CT	APP	N	N	A	N	N
Van Bosse et al. (86)	2015	103	NR (10;40)	N	Y	NR	Y	N	CT	APP	N	N	F	A	N
Vandenbussche et al. (87)	2008	200	55 (18;88)	N	N		Y	N	CT	APP	N	R	N	N	N
Wang et al. (88)	2017	98	36 (18;56)	N	N		Y	N	CT	APP	N	R	N	N	N
Wang et al. (89)	2019	20	25 (16;38)	N	Y	1,2	N	N	CT	APP	Y	N	A/F/S	N	N
Wang et al. (90)	2016	4	25 (21;29)	N	Y	NR	Y	N	CT	NRP	Y	N	F/S	N	N
Wassilew et al. (91)	2017	200	27 (18;35)	N	N		Y	N	CT	APP	Y	R	N	N	N
Wenzl et al. (92)	2017	20	NR	N	N		Y	N	CT	APP	Y	N	N	C	N
Xu et al. (93)	2018	128	24 (20;46)	N	Y	1	Y	N	CT	NRP	Y	N	F/S	C	N
Xuyi et al. (94)	2016	149	40 (14;69)	N	Y	NR	Y	N	CT	APP	Y	N	A/F/S	N	N
Yan et al. (95)	2018	33	35 (NR)	N	Y	NR	N	Y	CT,MRI	NRP	Y	N	F	A/C	N
Yang et al. (96)	2017	115	50 (37;65)	N	Y	1,2,3,4	Y	N	CT	APP	N	N	F/S	C	N
Yoshitani et al. (97)	2019	102	64 (32;86)	N	Y	4	Y	N	CT	APP	N	N	N	N	N
Zhang et al. (98)	2017	200	47 (18;60)	N	N		Y	N	CT	APP	N	R	N	N	N

Supplemental File. Study reviewing of 98 articles
If number of hips was not reported, number of patients is noted
NR: not reported, Y/N : yes/no
Reference planes: APP (anterior pelvic plane)/ STC (standardized terminology committee)/ SB (sacral base)/ NRP (non-reproducible plane)
Global orientation method: N(no)/ R (acetabular rim)/ SP (successive planes)/ S (surface)
Triplanar measurement and acetabular segmentation: N (no)/ A (axial)/ S (sagittal)/ F (frontal)/ C (clockwise)

References:

1. Abel MF, Sutherland DH, Wenger DR, Mubarak SJ. Evaluation of CT scans and 3-D reformatted images for quantitative assessment of the hip. J Pediatr Orthop. 1994;14:48–53. doi: 10.1097/01241398-199401000-00011.
2. Agten CA, Jonczy M, Ullrich O, Pfirrmann CWA, Sutter R, Buck FM. Measurement of acetabular version based on biplanar radiographs with 3D reconstructions in comparison to CT as reference standard in cadavers. Clin Anat. 2017;30:591–598. doi: 10.1002/ca.22874.
3. Akiyama K, Sakai T, Koyanagi J, Yoshikawa H, Sugamoto K. Evaluation of translation in the normal and dysplastic hip using three-dimensional magnetic resonance imaging and voxel-based registration. Osteoarthr. Cartil. 2011;19:700–710. doi: 10.1016/j.joca.2011.01.017.
4. Archbold H a. P, Slomczykowski M, Crone M, Eckman K, Jaramaz B, Beverland DE. The relationship of the orientation of the transverse acetabular ligament and acetabular labrum to the suggested safe zones of cup positioning in total hip arthroplasty. Hip Int. 2008;18:1–6. doi: 10.5301/hip.2008.1755.
5. Armand M, Lepistö J, Tallroth K, Elias J, Chao E. Outcome of periacetabular osteotomy: joint contact pressure calculation using standing AP radiographs, 12 patients followed for average 2 years. Acta Orthop. 2005;76:303–313.
6. Armiger RS, Armand M, Tallroth K, Lepistö J, Mears SC. Three-dimensional mechanical evaluation of joint contact pressure in 12 periacetabular osteotomy patients with 10-year follow-up. Acta Orthop. 2009;80:155–161. doi: 10.3109/17453670902947390.
7. Bouma H, Hogervorst T, Audenaert E, van Kampen P. Combining femoral and acetabular parameters in femoroacetabular impingement: the omega surface. Med Biol Eng Comput. 2015;53:1239–1246. doi: 10.1007/s11517-015-1392-6.
8. Bouma HW, Hogervorst T, Audenaert E, Krekel P, van Kampen PM. Can combining femoral and acetabular morphology parameters improve the characterization of femoroacetabular impingement? Clin Orthop Relat Res. 2015;473:1396–1403. doi: 10.1007/s11999-014-4037-4.
9. Caffrey JP, Jeffords ME, Farnsworth CL, Bomar JD, Upasani VV. Comparison of 3 Pediatric Pelvic Osteotomies for Acetabular Dysplasia Using Patient-specific 3D-printed Models. J Pediatr Orthop. 2019;39:e159–e164. doi: 10.1097/BPO.0000000000001271.
10. Cai Z, Zhao Q, Li L, Zhang L, Ji S. Can Computed Tomography Accurately Measure Acetabular Anter-version in Developmental Dysplasia of the Hip? Verification and Characterization Using 3D Printing Technology. J Pediatr Orthop. 2018;38:e180–e185. doi: 10.1097/BPO.0000000000001141.
11. Cerveri P, Marchente M, Chemello C, Confalonieri N, Manzotti A, Baroni G. Advanced computational framework for the automatic analysis of the acetabular morphology from the pelvic bone surface for hip arthroplasty applications. Ann Biomed Eng. 2011;39:2791–2806. doi: 10.1007/s10439-011-0375-5.
12. Chang CH, Kuo KN, Wang CJ, Chen YY, Cheng HY, Kao HK. Acetabular deficiency in spastic hip subluxation. J Pediatr Orthop. 2011;31:648–654. doi: 10.1097/BPO.0b013e318228903d.
13. Cheng R, Zhang H, Kernkamp WA, Zheng J, Dai K, Yao Y, Wang L, Tsai T-Y. Relations between the Crowe classification and the 3D femoral head displacement in patients with developmental dysplasia of the hip. BMC Musculoskelet Disord. 2019;20:530. doi: 10.1186/s12891-019-2838-z.

14. Chung CY, Park MS, Choi IH, Cho T-J, Yoo WJ, Lee KM. Morphometric analysis of acetabular dysplasia in cerebral palsy. J Bone Joint Surg Br. 2006;88:243–247. doi: 10.1302/0301-620X.88B2.16274.
15. Dandachli W, Kannan V, Richards R, Shah Z, Hall-Craggs M, Witt J. Analysis of cover of the femoral head in normal and dysplastic hips: new CT-based technique. J Bone Joint Surg Br. 2008;90:1428–1434. doi: 10.1302/0301-620X.90B11.20073.
16. Dandachli W, Najefi A, Iranpour F, Lenihan J, Hart A, Cobb J. Quantifying the contribution of pincer deformity to femoro-acetabular impingement using 3D computerised tomography. Skeletal Radiol. 2012;41:1295–1300. doi: 10.1007/s00256-012-1389-2.
17. Dandachli W, Richards R, Sauret V, Cobb JP. The transverse pelvic plane: a new and practical reference frame for hip arthroplasty. Comput Aided Surg. 2006;11:322–326. doi: 10.3109/10929080601090706.
18. Dandachli W, Ul Islam S, Tippett R, Hall-Craggs MA, Witt JD. Analysis of acetabular version in the native hip: comparison between 2D axial CT and 3D CT measurements. Skeletal Radiol. 2011;40:877–883. doi: 10.1007/s00256-010-1065-3.
19. Durand-Hill M, Henckel J, Satchithananda K, Sabah S, Hua J, Hothi H, Langstaff RJ, Skinner J, Hart A. Calculating the hip center of rotation using contralateral pelvic anatomy. J Orthop Res. 2016;34:1077–1083. doi: 10.1002/jor.23118.
20. Falliner A, Muhle C, Brossmann J. Acetabular inclination and anteversion in infants using 3D MR imaging. Acta Radiol. 2002;43:221–224. doi: 10.1080/028418502127347826.
21. Fujii M, Nakashima Y, Sato T, Akiyama M, Iwamoto Y. Pelvic deformity influences acetabular version and coverage in hip dysplasia. Clin Orthop Relat Res. 2011;469:1735–1742. doi: 10.1007/s11999-010-1746-1.
22. Gillard FC, Dickinson AS, Schneider U, Taylor AC, Browne M. Multi-pelvis characterisation of articular cartilage geometry. Proc Inst Mech Eng H. 2013;227:1255–1264. doi: 10.1177/0954411913500265.
23. Gose S, Sakai T, Shibata T, Murase T, Yoshikawa H, Sugamoto K. Morphometric analysis of acetabular dysplasia in cerebral palsy: three-dimensional CT study. J Pediatr Orthop. 2009;29:896–902. doi: 10.1097/BPO.0b013e3181c0e957.
24. Gu D, Chen Y, Dai K, Zhang S, Yuan J. The shape of the acetabular cartilage surface: a geometric mor-phometric study using three-dimensional scanning. Med Eng Phys. 2008;30:1024–1031. doi: 10.1016/j.medengphy.2007.12.013.
25. Ha Y-C, Yoo JJ, Lee Y-K, Kim JY, Koo K-H. Acetabular component positioning using anatomic landmarks of the acetabulum. Clin Orthop Relat Res. 2012;470:3515–3523. doi: 10.1007/s11999-012-2460-y.
26. Haimerl M, Schubert M, Wegner M, Kling S. Anatomical relationships of human pelvises and their ap-plication to registration techniques. Comput Aided Surg. 2012;17:232–239. doi: 10.3109/10929088.2012.711368.
27. Hamada H, Takao M, Sakai T, Sugano N. Morphological variation of the anterior inferior iliac spine affects hip range of motion in flexion after rotational acetabular osteotomy. Int Orthop. 2018;42:1247–1252. doi: 10.1007/s00264-017-3673-1.
28. Hansen BJ, Harris MD, Anderson LA, Peters CL, Weiss JA, Anderson AE. Correlation between radiographic measures of acetabular morphology with 3D femoral head coverage in patients with acetabular retroversion. Acta Orthop. 2012;83:233–239. doi: 10.3109/17453674.2012.684138.
29. Harrington ME, Zavatsky AB, Lawson SEM, Yuan Z, Theologis TN. Prediction of the hip joint centre in adults, children, and patients with cerebral palsy based on magnetic resonance imaging. J Biomech. 2007;40:595–602. doi: 10.1016/j.jbiomech.2006.02.003.
30. Hashemi SA, Dehghani J, Vosoughi AR. Can the crossover sign be a reliable marker of global retroversion of the acetabulum? Skeletal Radiol. 2017;46:17–21. doi: 10.1007/s00256-016-2497-1.
31. Hausselle J, Moreau PE, Wessely L, de Thomasson E, Assi A, Parratte S, Essig J, Skalli W. Intra- and extra-articular planes of reference for use in total hip arthroplasty: a preliminary study. Int Orthop. 2012;36:1567–1573. doi: 10.1007/s00264-012-1516-7.

32. Hayashi S, Hashimoto S, Matsumoto T, Takayama K, Kamenaga T, Niikura T, Kuroda R. Preoperative anterior coverage of the medial acetabulum can predict postoperative anterior coverage and range of motion after periacetabular osteotomy: a cohort study. J Orthop Surg Res. 2020;15:312. doi: 10.1186/s13018-020-01818-z.
33. Hayashi S, Nishiyama T, Fujishiro T, Kanzaki N, Shibanuma N, Kobashi S, Kurosaka M. Automated pelvic anatomical coordinate system is reproducible for determination of anterior pelvic plane. Comput Methods Biomech Biomed Engin. 2013;16:937–942. doi: 10.1080/10255842.2011.644541.
34. Herman M, Krivoniak A, Ruh E, Thakrar D, Bosch P, Wylie JD, Ghodadra A, McClincy MP. Acetabular Coverage Decreases at the End of Skeletal Growth: A 3DCT Study of Healthy Hips. J Pediatr Orthop. 2021;41:e232–e239. doi: 10.1097/BPO.0000000000001742.
35. Hettich G, Schierjott RA, Ramm H, Graichen H, Jansson V, Rudert M, Traina F, Grupp TM. Method for quantitative assessment of acetabular bone defects. J Orthop Res. 2019;37:181–189. doi: 10.1002/jor.24165.
36. Imai N, Suzuki H, Nozaki A, Hirano Y, Endo N. Correlation of tilt of the anterior pelvic plane angle with anatomical pelvic tilt and morphological configuration of the acetabulum in patients with developmental dysplasia of the hip: a cross-sectional study. J Orthop Surg Res. 2019;14:323. doi: 10.1186/s13018-019-1382-8.
37. Irie T, Espinoza Orías AA, Irie TY, Nho SJ, Takahashi D, Iwasaki N, Inoue N. Computed Tomogra-phy-Based Three-Dimensional Analyses Show Similarities in Anterosuperior Acetabular Coverage Between Acetabular Dysplasia and Borderline Dysplasia. Arthroscopy. 2020;36:2623–2632. doi: 10.1016/j.arthro.2020.05.049.
38. Irie T, Espinoza Orías AA, Irie TY, Nho SJ, Takahashi D, Iwasaki N, Inoue N. Three-dimensional hip joint congruity evaluation of the borderline dysplasia: Zonal-acetabular radius of curvature. J Orthop Res. 2020;38:2197–2205. doi: 10.1002/jor.24631.
39. Irie T, Orías AAE, Irie TY, Nho SJ, Takahashi D, Iwasaki N, Inoue N. Three-dimensional curvature mismatch of the acetabular radius to the femoral head radius is increased in borderline dysplastic hips. PLoS One. 2020;15:e0231001. doi: 10.1371/journal.pone.0231001.
40. Ito H, Matsuno T, Hirayama T, Tanino H, Yamanaka Y, Minami A. Three-dimensional computed to-mography analysis of non-osteoarthritic adult acetabular dysplasia. Skeletal Radiol. 2009;38:131–139. doi: 10.1007/s00256-008-0601-x.
41. Janzen DL, Aippersbach SE, Munk PL, Sallomi DF, Garbuz D, Werier J, Duncan CP. Three-dimensional CT measurement of adult acetabular dysplasia: technique, preliminary results in normal subjects, and potential ap-plications. Skeletal Radiol. 1998;27:352–358. doi: 10.1007/s002560050397.
42. Jia J, Li L, Zhang L, Zhao Q, Liu X. Three dimensional-CT evaluation of femoral neck anteversion, ace-tabular anteversion and combined anteversion in unilateral DDH in an early walking age group. Int Orthop. 2012;36:119–124. doi: 10.1007/s00264-011-1337-0.
43. Jia J, Li L, Zhang L, Zhao Q, Wang E, Li Q. Can excessive lateral rotation of the ischium result in increased acetabular anteversion? A 3D-CT quantitative analysis of acetabular anteversion in children with unilateral de-velopmental dysplasia of the hip. J Pediatr Orthop. 2011;31:864–869. doi: 10.1097/BPO.0b013e31823832ce.
44. Jóźwiak M, Rychlik M, Musielak B, Chen BP-J, Idzior M, Grzegorzewski A. An accurate method of radiological assessment of acetabular volume and orientation in computed tomography spatial reconstruction. BMC Musculoskelet Disord. 2015;16:42. doi: 10.1186/s12891-015-0503-8.
45. Jóźwiak M, Rychlik M, Szymczak W, Grzegorzewski A, Musielak B. Acetabular shape and orientation of the spastic hip in children with cerebral palsy. Dev Med Child Neurol. 2021;63:608–613. doi: 10.1111/dmcn.14793.
46. Kamenaga T, Hayashi S, Hashimoto S, Fukuda K, Takayama K, Tsubosaka M, Takashima Y, Niikura T, Kuroda R, Matsumoto T. Pelvic morphology medial to the femoral head center predicts anterior coverage and range of motion after curved periacetabular osteotomy. J Orthop Res. 2020;38:2031–2039. doi: 10.1002/jor.24624.
47. Karami M, Gouran Savadkoohi D, Ghadirpoor A, Rahimpour S, Rahimpoor S, Azghani M, Farahmand F. A computer model for evaluating the osteotomy parameters of Chiari pelvic osteotomy. Int Orthop. 2010;34:329–333. doi: 10.1007/s00264-009-0769-2.
48. Kim J-T, Shen QH, Jeon C-H, Chung N-S, Jeong S, Lee H-D. No linear correlation between pelvic incidence and acetabular orientation: Retrospective observational study. Medicine (Baltimore). 2021;100:e25445. doi: 10.1097/MD.0000000000025445.
49. Kohno Y, Nakashima Y, Fujii M, Shiomoto K, Iwamoto M. Acetabular retroversion in dysplastic hips is associated with decreased 3D femoral head coverage independently from lateral center-edge angle. Arch Orthop Trauma Surg. 2020;140:869–875. doi: 10.1007/s00402-019-03277-6.

50. Kohno Y, Nakashima Y, Hatano T, Akiyama M, Fujii M, Hara D, Kanazawa M, Haraguchi A, Iwamoto Y. High prevalence of cam deformity in dysplastic hips: A three-dimensional CT study. J Orthop Res. 2016;34:1613–1619. doi: 10.1002/jor.23147.
51. Larson CM, Moreau-Gaudry A, Kelly BT, Byrd JWT, Tonetti J, Lavallee S, Chabanas L, Barrier G, Bedi A. Are normal hips being labeled as pathologic? A CT-based method for defining normal acetabular coverage. Clin Orthop Relat Res. 2015;473:1247–1254. doi: 10.1007/s11999-014-4055-2.
52. Lee C, Jang J, Kim HW, Kim YS, Kim Y. Three-dimensional analysis of acetabular orientation using a semi-automated algorithm. Comput Assist Surg (Abingdon). 2019;24:18–25. doi: 10.1080/24699322.2018.1545872.
53. Legaye J, Duval-Beaupere G, Barrau A, Boulay C, Hecquet J, Montigny J-P, Tardieu C. Relationship between sacral pelvic incidence and acetabular orientation. Hip Int. 2011;21:87–97. doi: 10.5301/hip.2011.6283.
54. Liu L, Ecker T, Schumann S, Siebenrock K, Nolte L, Zheng G. Computer assisted planning and navigation of periacetabular osteotomy with range of motion optimization. Med Image Comput Comput Assist Interv. 2014;17:643–650. doi: 10.1007/978-3-319-10470-6_80.
55. Liu L, Ecker T, Xie L, Schumann S, Siebenrock K, Zheng G. Biomechanical validation of computer assisted planning of periacetabular osteotomy: A preliminary study based on finite element analysis. Med Eng Phys. 2015;37:1169–1173. doi: 10.1016/j.medengphy.2015.09.002.
56. Lubovsky O, Peleg E, Joskowicz L, Liebergall M, Khoury A. Acetabular orientation variability and symmetry based on CT scans of adults. Int J CARS. 2010;5:449–454. doi: 10.1007/s11548-010-0521-9.
57. Lubovsky O, Wright D, Hardisty M, Kiss A, Kreder H, Whyne C. Acetabular orientation: anatomical and functional measurement. Int J CARS. 2012;7:233–240. doi: 10.1007/s11548-011-0648-3.
58. Mascarenhas VV, Rego P, Dantas P, Caetano AP, Jans L, Sutter R, Marques RM, Ayeni OR, Consciência JG. Can We Discriminate Symptomatic Hip Patients From Asymptomatic Volunteers Based on Anatomic Predictors? A 3-Dimensional Magnetic Resonance Study on Cam, Pincer, and Spinopelvic Parameters. Am J Sports Med. 2018;46:3097–3110. doi: 10.1177/0363546518800825.
59. Mascarenhas VV, Rego P, Dantas P, Castro M, Jans L, Marques RM, Gouveia N, Soldado F, Ayeni OR, Consciência JG. Hip shape is symmetric, non-dependent on limb dominance and gender-specific: implications for femoroacetabular impingement. A 3D CT analysis in asymptomatic subjects. Eur Radiol. 2018;28:1609–1624. doi: 10.1007/s00330-017-5072-9.
60. Miyasaka D, Sakai Y, Ibuchi S, Suzuki H, Imai N, Endo N. Sex- and age-specific differences in femoral head coverage and acetabular morphology among healthy subjects-derivation of normal ranges and thresholds for ab-normality. Skeletal Radiol. 2017;46:523–531. doi: 10.1007/s00256-017-2583-z.
61. Miyasaka D, Ito T, Imai N, Suda K, Minato I, Dohmae Y, Endo N. Three-dimensional Assessment of Femoral Head Coverage in Normal and Dysplastic Hips: A Novel Method. Acta Med Okayama. 2014;68:277–284. doi: 10.18926/AMO/52896.
62. Murtha PE, Hafez MA, Jaramaz B, DiGioia AM. Variations in acetabular anatomy with reference to total hip replacement. J Bone Joint Surg Br. 2008;90:308–313. doi: 10.1302/0301-620X.90B3.19548.
63. Musielak B, Jóźwiak M, Rychlik M, Chen BP-J, Idzior M, Grzegorzewski A. Does hemipelvis structure and position influence acetabulum orientation? BMC Musculoskelet Disord. 2016;17:131. doi: 10.1186/s12891-016-0982-2.
64. Musielak B, Rychlik M, Jóźwiak M. Sexual Dimorphism of Acetabular Anatomy Based on Three-dimensional Computed Tomography Image of Pelvises. Ortop Traumatol Rehabil. 2016;18:451–459. doi: 10.5604/15093492.1226275.
65. Nakahara I, Takao M, Sakai T, Nishii T, Yoshikawa H, Sugano N. Gender differences in 3D morphology and bony impingement of human hips. J Orthop Res. 2011;29:333–339. doi: 10.1002/jor.21265.
66. Nakamura S, Yorikawa J, Otsuka K, Takeshita K, Harasawa A, Matsushita T. Evaluation of acetabular dysplasia using a top view of the hip on three-dimensional CT. J Orthop Sci. 2000;5:533–539. doi: 10.1007/s007760070001.

67. Nardi C, De Falco L, Caracchini G, Calistri L, Mercatelli L, Cristin S, Lorini C, Cavigli E, Landini N, Orlandi M, Carulli , Miele V. A three-dimensional measurement method on MR arthrography of the hip to classify femoro-acetabular impingement. Jpn J Radiol. 2021;39:1175–1185. doi: 10.1007/s11604-021-01162-0.
68. Needell SD, Borzykowski RM, Carreira DS, Kozy J. CT false-profile view of the hip: a reproducible method of measuring anterior acetabular coverage using volume CT data. Skeletal Radiol. 2014;43:1605–1611. doi: 10.1007/s00256-014-1949-8.
69. Nepple JJ, Wells J, Ross JR, Bedi A, Schoenecker PL, Clohisy JC. Three Patterns of Acetabular Deficiency Are Common in Young Adult Patients With Acetabular Dysplasia. Clin Orthop Relat Res. 2017;475:1037–1044. doi: 10.1007/s11999-016-5150-3.
70. Osmani HT, Henckel J, Cobb J, Hart AJ. Native Acetabular Version: 3D CT Analysis of the Psoas Valley. HIP International. 2013;23:274–280. doi: 10.5301/hipint.5000007.
71. Park J, Kim J-Y, Kim HD, Kim YC, Seo A, Je M, Mun JU, Kim B, Park IH, Kim S-Y. Analysis of acetabular orientation and femoral anteversion using images of three-dimensional reconstructed bone models. Int J Comput Assist Radiol Surg. 2017;12:855–864. doi: 10.1007/s11548-016-1514-0.
72. Park J, Kim GL, Yang KH. Anatomical landmarks for acetabular abduction in adult hips: the teardrop vs. the inferior acetabular rim. Surg Radiol Anat. 2019;41:1505–1511. doi: 10.1007/s00276-019-02329-1.
73. Perreira AC, Hunter JC, Laird T, Jamali AA. Multilevel measurement of acetabular version using 3-D CT-generated models: implications for hip preservation surgery. Clin Orthop Relat Res. 2011;469:552–561. doi: 10.1007/s11999-010-1567-2.
74. Peterson JB, Doan J, Bomar JD, Wenger DR, Pennock AT, Upasani VV. Sex Differences in Cartilage Topography and Orientation of the Developing Acetabulum: Implications for Hip Preservation Surgery. Clin Orthop Relat Res. 2015;473:2489–2494. doi: 10.1007/s11999-014-4109-5.
75. Puls M, Ecker TM, Steppacher SD, Tannast M, Siebenrock KA, Kowal JH. Automated detection of the osseous acetabular rim using three-dimensional models of the pelvis. Comput Biol Med. 2011;41:285–291. doi: 10.1016/j.compbiomed.2011.03.004.
76. Rasquinha BJ, Sayani J, Rudan JF, Wood GCA, Ellis RE. Articular surface remodeling of the hip after periacetabular osteotomy. Int J Comput Assist Radiol Surg. 2012;7:241–248. doi: 10.1007/s11548-011-0641-x.
77. Sakai T, Nishii T, Sugamoto K, Yoshikawa H, Sugano N. Is vertical-center-anterior angle equivalent to anterior coverage of the hip? Clin Orthop Relat Res. 2009;467:2865–2871. doi: 10.1007/s11999-009-0802-1.
78. Sautet P, Giorgi H, Chabrand P, Tropiano P, Argenson J-N, Parratte S, Blondel B. Is anatomic acetabular orientation related to pelvic morphology? CT analysis of 150 healthy pelvises. Orthop Traumatol Surg Res. 2018;104:347–351. doi: 10.1016/j.otsr.2017.10.006.
79. Suh DH, Lee DH, Jeong WK, Park SW, Kang CH, Lee SH. Virtual Bernese osteotomy using three-dimensional computed tomography in hip dysplasia. Arch Orthop Trauma Surg. 2012;132:447–454. doi: 10.1007/s00402-011-1435-x.
80. Suzuki D, Nagoya S, Takashima H, Tateda K, Yamashita T. Three-dimensional orientation of the acetabulum. Clin Anat. 2017;30:753–760. doi: 10.1002/ca.22945.
81. Tanaka T, Moro T, Ishikura H, Hashikura K, Kaneko T, Tanaka S. Characteristics of three-dimensional acetabular morphology of patients with excellent outcome after rotational acetabular osteotomy over 20 years. J Orthop Surg Res. 2021;16:192. doi: 10.1186/s13018-021-02346-0.
82. Tanaka T, Moro T, Takatori Y, Oshima H, Ito H, Sugita N, Mitsuishi M, Tanaka S. Evaluation of the three-dimensional bony coverage before and after rotational acetabular osteotomy. Int Orthop. 2018;42:2527–2534. doi: 10.1007/s00264-018-3851-9.
83. Uemura K, Atkins PR, Peters CL, Anderson AE. The effect of pelvic tilt on three-dimensional coverage of the femoral head: A computational simulation study using patient-specific anatomy. Anat Rec (Hoboken). 2021;304:258–265. doi: 10.1002/ar.24320.
84. Upasani VV, Bomar JD, Bandaralage H, Doan JD, Farnsworth CL. Assessment of three-dimensional acetabular coverage angles. J Hip Preserv Surg. 2020;7:305–312. doi: 10.1093/jhps/hnaa026.
85. van Bosse HJP, Lee D, Henderson ER, Sala DA, Feldman DS. Pelvic positioning creates error in CT acetabular measurements. Clin Orthop Relat Res. 2011;469:1683–1691. doi: 10.1007/s11999-011-1827-9.

86. van Bosse H, Wedge JH, Babyn P. How are dysplastic hips different? A three-dimensional CT study. Clin Orthop Relat Res. 2015;473:1712–1723. doi: 10.1007/s11999-014-4103-y.
87. Vandenbussche E, Saffarini M, Taillieu F, Mutschler C. The asymmetric profile of the acetabulum. Clin Orthop Relat Res. 2008;466:417–423. doi: 10.1007/s11999-007-0062-x.
88. Wang RY, Xu WH, Kong XC, Yang L, Yang SH. Measurement of acetabular inclination and anteversion via CT generated 3D pelvic model. BMC Musculoskelet Disord. 2017;18:373. doi: 10.1186/s12891-017-1714-y.
89. Wang X, Liu S, Peng J, Zhu Z, Zhang L, Guan J, Chen X. Development of a novel customized cutting and rotating template for Bernese periacetabular osteotomy. J Orthop Surg Res. 2019;14:217. doi: 10.1186/s13018-019-1267-x.
90. Wang X, Peng J, Li D, Zhang L, Wang H, Jiang L, Chen X. Does the optimal position of the acetabular fragment should be within the radiological normal range for all developmental dysplasia of the hip? A pa-tient-specific finite element analysis. J Orthop Surg Res. 2016;11:109. doi: 10.1186/s13018-016-0445-3.
91. Wassilew GI, Heller MO, Janz V, Perka C, Müller M, Renner L. High prevalence of acetabular retroversion in asymptomatic adults: a 3D CT-based study. Bone Joint J. 2017;99-B:1584–1589. doi: 10.1302/0301-620X.99B12.37081.
92. Wenzl MP, Heller M, Janz V, Perka C, Wassilew GI. Validation of CT image-based software for three-dimensional measurement of acetabular coverage profile. Technol Health Care. 2017;25:989–1004. doi: 10.3233/THC-170932.
93. Xu M, Wang Y, Zhong L, Song Y, Xiao J, Sun Y, Li W, Zhu Z, Zhao X, Wang J. Three-dimensional morphology of lunate surface in hip dysplasia: Theoretical implications for periacetabular osteotomy. J Orthop Sci. 2018;23:81–87. doi: 10.1016/j.jos.2017.11.008.
94. Xuyi W, Jianping P, Junfeng Z, Chao S, Yimin C, Xiaodong C. Application of three-dimensional com-puterised tomography reconstruction and image processing technology in individual operation design of devel-opmental dysplasia of the hip patients. Int Orthop. 2016;40:255–265. doi: 10.1007/s00264-015-2994-1.
95. Yan K, Xi Y, Sasiponganan C, Zerr J, Wells JE, Chhabra A. Does 3DMR provide equivalent information as 3DCT for the pre-operative evaluation of adult Hip pain conditions of femoroacetabular impingement and Hip dysplasia? Br J Radiol. 2018;91:20180474. doi: 10.1259/bjr.20180474.
96. Yang Y, Zuo J, Liu T, Xiao J, Liu S, Gao Z. Morphological Analysis of True Acetabulum in Hip Dysplasia (Crowe Classes I-IV) Via 3-D Implantation Simulation. J Bone Joint Surg Am. 2017;99:e92. doi: 10.2106/JBJS.16.00729.
97. Yoshitani J, Kabata T, Kajino Y, Ueno T, Ueoka K, Nakamura T, Tsuchiya H. Morphometric geometrical analysis to determine the centre of the acetabular component placement in Crowe type IV hips undergoing total hip arthroplasty. Bone Joint J. 2019;101-B:189–197. doi: 10.1302/0301-620X.101B2.BJJ-2018-1076.R1.
98. Zhang H, Wang Y, Ai S, Chen X, Wang L, Dai K. Three-dimensional acetabular orientation measurement in a reliable coordinate system among one hundred Chinese. PLoS One. 2017;12:e0172297. doi: 10.1371/journal.pone.0172297.