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A possible prediction of dystocia at the time of cesarean delivery

Gluteal muscle contracture, a single center experience from China

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Abstract

The study assessed the pelvic dimensions by computed tomography (CT) performed for gluteal muscle contracture women, and evaluated the impact of malformations on several essential obstetric parameters.

The CT pelvimetry was retrospectively performed in 25 gluteal muscle contracture women selected consecutively whether they had delivery history or not. Among the pelvic inlet plane, the mid plane and the outlet plane, 12 indicators including the transverse diameter of the pelvic inlet, the conjugate vera, the diagonal conjugate, the biischial diameter, the anteroposterior diameter of the middle pelvis, transverse outlet, the posterior sagittal diameter of outlet, the conjugate of the outlet, the anterior sagittal diameter of the outlet, the curvature and length of the sacrum, the angle of pubic arch were collected.

Finally, the mean age of these women was 26.6 ± 5.0 years. Most pelvises had anteroposterior elliptical appearance in inlet and size of the female pelvis. The most statistically different and most clinically significant indicator was the biischial diameter, gluteal muscle contracture women were 95.6 ± 9.3 mm and the normal women from other study were 105.0 ± 7.9 mm, the comparison showed a significant difference ($P < .001$).

Generally, most gluteal muscle contracture women had features of anthropoid pelvis which were quite different from normal Chinese female. These results may serve as a basis for future studies to assess its utility and prognostic value for a safe vaginal delivery in gluteal muscle contracture women.

Abbreviations: 3D = 3-dimensional, CT = computed tomography, GF = gluteal fibrosis, GMC = gluteal muscle contracture.

Keywords: gluteal muscle contracture, gluteal fibrosis, bony birth canal, computed tomography imaging, pelvimetry, 3-dimensional reconstruction

1. Introduction

Gluteal muscle contracture (GMC), also named gluteal fibrosis, is a clinical syndrome characterized by gait abnormality, limb dysfunction, and secondary deformities of pelvis.

The GMC was 1st found by Valderrama in London in 1969,[1] and has been reported from around the world, including China, South Korea, India, Iraq, Poland, Uganda, and the United States.[2–9] It was reported that GMC was associated with repeated intramuscular injection of benzyl alcohol into the gluteal region during childhood, which was characterized by accumulation of collagen types I and III.[10] At present, arthroscopic release, a minimally invasive surgery which was reported by Zhang et al[11] for the 1st time, has become the gold standard of treatment in patients with GMC.[12,13] GMC mainly affects the patient's tensor fasciae latae, gluteus maximus, gluteus medius, and gluteus minimus, leading to a sequence of secondary pathologic changes, such as pelvic tilt, and acetabular dysplasia.[2]

In orthopedics clinics, we noted that GMC was often accompanied by pelvic narrowing. In addition, some female patients who performed pelvic narrowing often had dystocia history in the past. So far, there has been no study of patients who have GMC to assess morphologic condition of the bony birth canal. Owing to the high prevalence in the world, if GMC is a possible prediction of dystocia, it should be placed in a more

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important position and its typical symptoms should be acquainted by obstetricians. In this study, we evaluated the influence of pelvic deformities on the morphologic condition and pelvis data in women with GMC. For women who are or will be at childbearing age, these data may be useful clinically in both orthopedic and obstetric treatment.

2. Methods

Inclusion criteria: Chinese women with gait abnormality and hip dysfunction in adduction and intorsion; the hips met all of the radiographic changes: gluteal muscle atrophy, contracture band, and osseous deformity[3]; and the patients volunteered to participate in this study.

Exclusion criteria: The patients had hip diseases or injuries, such as the femoroacetabular impingement, the developmental dysplasia of hip, or hip fracture; and the patients were reluctant to join in the research.

By this selection process, 25 GMC volunteers were assigned to the study group. All patients were treated for the 1st time. After this research, we implemented the 3-step technique with arthroscope[12] and rehabilitation program of all the GMC women. Three months later, all the women gained the satisfactory results without complications, snappings, and hip dysfunctions. The study did not set a control group, using published data instead. All scans were made from January to July, 2017.

2.1. Available computed tomography data

In this study, 3-dimensional computed tomography (3D CT) scans were performed on CT scanners (Discovery 750HD; GE Healthcare, Waukesha, WI) with slice thickness varying between 0.625 and 2.5 mm and a gantry tilt of zero degree. All scans ranged from the pelvic bone to the proximal femur.

2.2. Three-dimensional reconstruction

The scan data were output according to the Digital Imaging and Communication in Medicine standard format, and were read using Boholo surgical simulator software (trial version; Boholo Medical Science, Shanghai, China) to rebuild the 3D images. The central exposure dose in the 3D CT examination was about 120 mGy.

2.3. 3D pelvimetry

According to the measuring method from Liu,[14] we totally measured 12 diameters and angles based on the digital 3D model of the whole pelvis and right half side of the pelvis, including the transverse diameter of the pelvic inlet, the conjugate vera, the diagonal conjugate, the biischial diameter, the anteroposterior diameter of the middle pelvis, transverse outlet, the posterior sagittal diameter of outlet, the conjugate of the outlet, the anterior sagittal diameter of the outlet, the curvature and length of the sacrum, and the angle of pubic arch (Fig. 1). The measurement data are in millimeter, and reserve to 1 decimal place.

2.4. Ethical approval

The study follows the ethical standards for human experimentation established in 1975 Helsinki declaration and its later amendments, and the ethical approval was obtained from the Ethics Committee at the authors' Hospital, Shenzhen, Guangdong Province, China (December 29, 2015). The risks from radiation exposure and the possible obstetric benefits of the prepregnancy determination of the morphologic condition of the bony birth canal were explained to all subjects, and their informed consent was obtained before the examination.

2.5. Statistical analysis

Statistical analysis was performed using the SPSS Software, Version 13.0 (SPSS Inc, Chicago, IL). All values were expressed as mean ± standard deviation. Statistics between our study and Liu's study[14] were compared using the Student t test. $P < .05$ was considered as statistically significant difference.

3. Results

3.1. General data

The mean age of participants was 26.6 ± 5.0 years (range 17–35 years) (Table 1). There were 3 gynecoid type pelvis (Fig. 2), and 22 anthropoid pelvises (Fig. 3). Among all the women, 2 gynecoid types and 3 anthropoid types had the history of cesarean birth, and 6 anthropoid people had the history of natural birth, combined with the other 14 women had no reproductive history (Table 1).

3.2. Main measurement results

At the pelvic inlet plane, the mean transverse diameter was 120.9 and 126.8 mm in the GMC women in this study and Liu's study, the mean conjugate vera was 133.5 and 122.4 mm, respectively. Both of the 2 comparisons had significant statistical significance ($P < .001$, Table 2).

At the mid plane of pelvis, the mean diagonal conjugate was 140.3 and 135.1 mm, the mean biischial diameter was 95.6 and 105.0 mm, and the mean anteroposterior diameter was 125.3 and 119.2 mm in the GMCs and literature participants separately. The statistical comparison of diagonal conjugate showed difference ($P < .05$), the comparison of biischial diameter and anteroposterior diameter had significant differences ($P < .001$ and $P < .01$, Table 2).

At the pelvic outlet plane, the mean transverse outlet was 93.3 and 121.8 mm, the mean posterior sagittal diameter was 83.9 and 55.6 mm, and the mean conjugate of the outlet was 121.1 and 111.3 mm in the GMCs and literature participants individually, as well as the mean anterior sagittal diameter of GMCs was 59.7 mm. The statistical comparison of the prior 3 values showed significant differences ($P < .001$, Table 2). The last one cannot be compared because of lacking Liu's data.

The mean curvature of the sacrum was 148.8° and 141.7°, the mean length of the sacrum was 107.5 and 109.4 mm, the mean angle of pubic arch was 88.7° and 88.2° in the GMCs and literature participants severally. The 1st value had statistical significance ($P < .05$, Table 2), while the last 2 data had no statistical differences ($P > .05$, Table 2).

4. Discussion

4.1. Main findings

This study demonstrates a special acquired pelvic deformity originated from GMC, which may affect whole bony birth canal

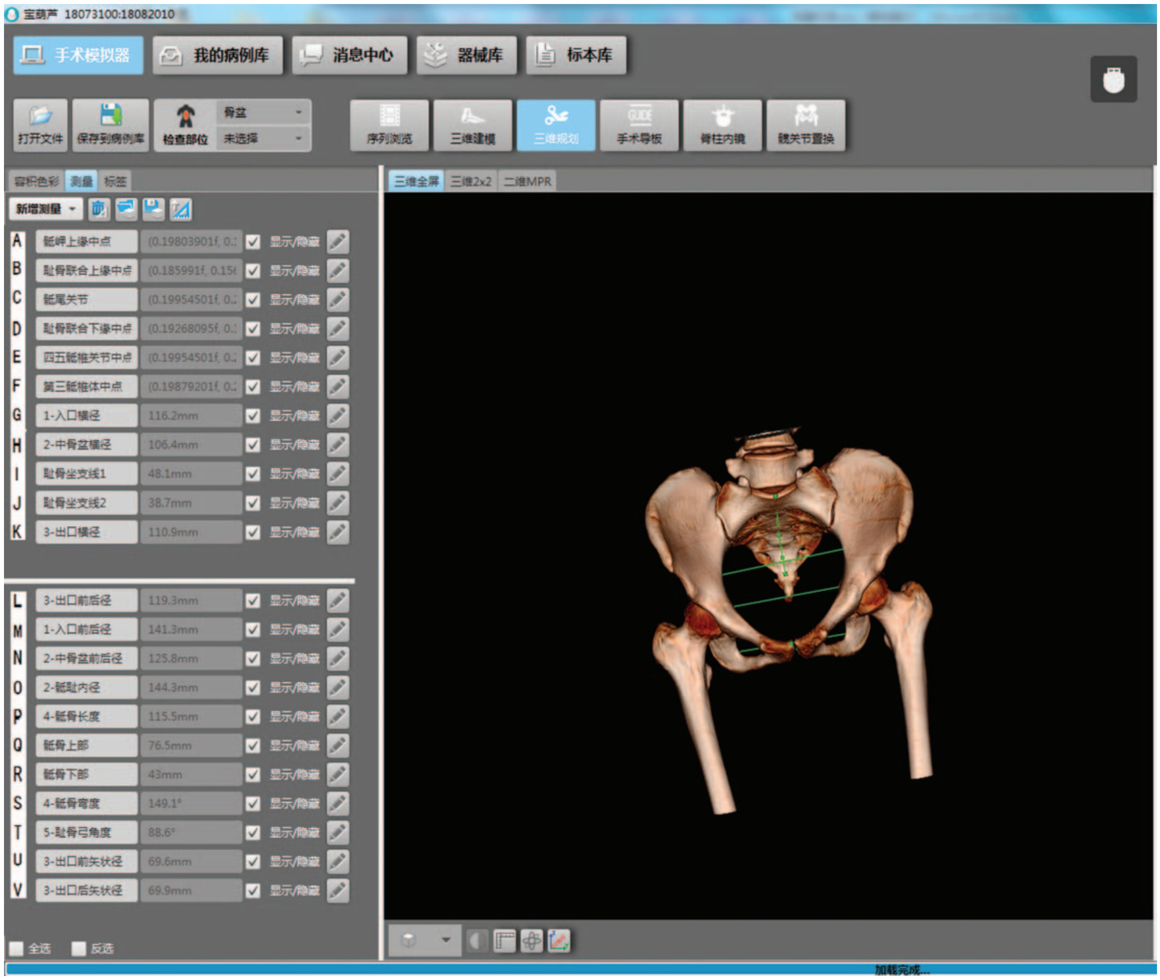

Figure 1. Measured parameters with 3-dimensional computed tomography. A = The midpoint of the superior border of sacral promontory, B = the midpoint of the superior border of symphysis pubis, C = the sacrococcygeal joint, D = the midpoint of the inferior margin of symphysis pubis, E = the midpoint of the S4/5 sacral vertebral joint, F = the centrum of the third sacral vertebrae, G = the transverse diameter of the pelvic inlet, H = the biischial diameter; I and J = the bilateral ischiopubic rami, K = the transverse outlet, L = the conjugate of the outlet, M = the conjugate vera, N = the anteroposterior diameter of the middle pelvis, O = the diagonal conjugate, P = the length of sacrum, Q = the upper part of sacrum, R = the lower part of sacrum, S = the curvature of sacrum, T = the angle of pubic arch, U = the anterior sagittal diameter of the outlet, V = the posterior sagittal diameter of outlet.

and has never been reported before. According to the results, the GMCs showed obvious characteristics with sagittal diameter increasing and transverse diameter decreasing in 3 planes from inlet to outlet. For lacking of control group, we referred Liu's study[14] of digital 3D reconstruction of normal female pelvis, which included 289 normal Han female in southern China and was divided into 3 groups: the youth group (109 cases, aged 25–40 years), the middle-aged group (115 cases, aged 41–50 years) and the old age group (65 cases, more than 50 years). In the youth group, the gynecoid type, platypelloid type, anthropoid type, and android type possessed 69.7%, 8.3%, 20.2%, 1.8%, respectively, while our study only includes 12% of gynecoid type and 88% of anthropoid type individually. Additionally, we compared the biischial diameter with Liu's data, and the most statistically different and most clinically significant value is the biischial diameter, GMC was 95.6±9.3 mm and the youth group was 105.0±7.9 mm ($P<.001$, Table 2). In fact, without the considering of the soft-tissue thickness, the real biischial diameter of these women in obstetrical practices should be much smaller.

4.2. Strengths and limitations

To the best of our knowledge, it is the 1st report (MEDLINE; 1966-May 2019; English language; search terms: "gluteal muscle contracture," "dystocia," "bony canal," and "gluteal fibrosis") of the measurement of bony birth canal in GMC women. Also, we discussed the clinical meanings of this study, pointed that this kind of pelvic deformity should be aroused more attention to, to reduce the risk of childbirth.

The study has a few limitations. Firstly, there was no control group, so all the data of normal women came from the published literature. Secondly, because the medical records on childbirth were unavailable, the study did not analyze the real reason of those caesarean sections synthetically, such as uterine action or fetus.

4.3. Interpretation

Decreased pelvic transverse diameters after pelvic osteotomy have been reported in several studies.[15,16] However, these studies had focused on the changings of pelvis after pelvic

Table 1

The data of participants.

	Age, yr	Pelvic type	Childbearing history	Transverse diameter of the pelvic inlet, mm	Conjugate vera, mm	Diagonal conjugate, mm	Biischial diameter, mm	Anteroposterior diameter of the middle pelvis, mm	Transverse outlet, mm	Posterior sagittal diameter of outlet, mm	Conjugate of the outlet, mm	Anterior sagittal diameter of the outlet, mm	Curvature of the sacrum, degree	Length of the sacrum, mm	Angle of pubic arch, degree
Peng	27	Anthropoid	None	121.7	151.5	163.6	98.0	156.7	91.4	101.4	145.9	69.5	136.0	107.3	89.5
Han	32	Anthropoid	Eutocia	120.3	141.7	150.6	92.2	139.7	87.9	90.0	128.2	60.3	120.4	100.4	86.1
Liu	27	Anthropoid	Eutocia	123.3	132.6	144.1	106.5	118.6	100.9	81.9	110.1	52.7	140.9	114.0	92.4
Lv	26	Anthropoid	None	130.8	138.3	149.5	83.4	130.1	70.2	82.3	125.6	65.2	153.9	111.4	66.2
Wu YL	21	Anthropoid	None	123.3	133.0	137.3	91.1	106.3	97.7	61.1	101.5	63.6	164.9	113.2	96.2
Wu FQ	29	Anthropoid	Cesarean	116.9	133.6	136.9	90.1	130.6	87.3	92.0	123.7	57.2	121.7	88.3	87.1
Zhou YQ	27	Anthropoid	Eutocia	125.1	140.5	143.7	107.1	120.4	97.5	88.5	112.9	53.0	143.4	108.5	104.9
Zhou X	17	Anthropoid	None	111.1	131.4	137.3	95.6	120.1	100.0	91.1	121.5	50.0	171.8	110.7	104.5
Zhang TL	27	Anthropoid	None	123.1	133.9	142.5	91.9	129.6	91.2	82.4	118.8	65.7	139.9	111.3	90.8
Zhang M	35	Anthropoid	Eutocia	127.5	127.4	137.8	95.7	122.5	93.4	86.4	121.9	56.5	140.1	112.6	94.3
Xu YH	25	Anthropoid	None	112.0	124.5	130.2	79.1	119.3	75.8	91.9	123.4	53.7	166.4	111.2	74.2
Dai	24	Gynecoid	None	134.0	125.5	137.0	112.3	138.4	111.0	100.7	132.2	55.7	167.6	107.3	95.9
Zeng	21	Anthropoid	None	118.7	131.4	134.2	100.5	125.0	98.8	95.6	125.2	48.4	158.0	105.1	98.3
Zhu	28	Anthropoid	Eutocia	127.6	142.1	148.4	107.4	128.3	106.5	79.2	120.5	66.1	142.6	110.9	92.6
Bi	35	Anthropoid	None	111.9	144.1	147.4	101.4	137.7	100.7	101.9	129.5	53.3	142.6	99.3	93.3
Lin	19	Anthropoid	None	111.9	136.8	137.7	83.5	126.0	81.8	85.1	119.3	54.9	138.5	104.2	79.5
Mo	22	Gynecoid	Cesarean	121.3	117.7	122.3	108.0	118.0	94.1	86.8	114.5	51.5	145.3	93.7	92.6
Yang	19	Anthropoid	None	126.4	138.3	147.4	91.8	121.6	82.8	71.1	121.8	67.6	156.8	123.1	79.6
Chen LL	31	Gynecoid	Cesarean	127.0	130.4	137.8	101.6	93.4	106.1	59.1	91.8	57.6	158.6	115.9	90.8
Chen YF	33	Anthropoid	Cesarean	124.0	136.2	147.3	85.7	133.7	86.4	78.9	129.0	71.4	162.2	110.8	80.7
Chen MY	25	Anthropoid	None	108.2	116.5	126.9	87.6	115.3	85.9	67.1	106.9	57.6	135.1	91.5	96.9
Gao	33	Anthropoid	Cesarean	128.3	130.6	137.1	88.6	135.6	93.8	94.5	133.8	62.3	149.7	101.7	76.3
Huang S	27	Anthropoid	None	120.8	141.1	149.8	106.6	130.4	106.7	79.0	125.0	69.0	147.9	115.5	84.4
Huang Q	25	Anthropoid	None	111.2	127.9	133.2	83.5	128.8	87.3	87.2	128.8	58.4	158.4	98.9	80.9
Xu MF	31	Anthropoid	Eutocia	115.3	129.4	126.6	100.8	105.4	97.0	62.9	116.0	71.5	156.4	120.6	89.2

Figure 2. One of the 3 gynecoid type pelvis using 3-dimensional computed tomography.

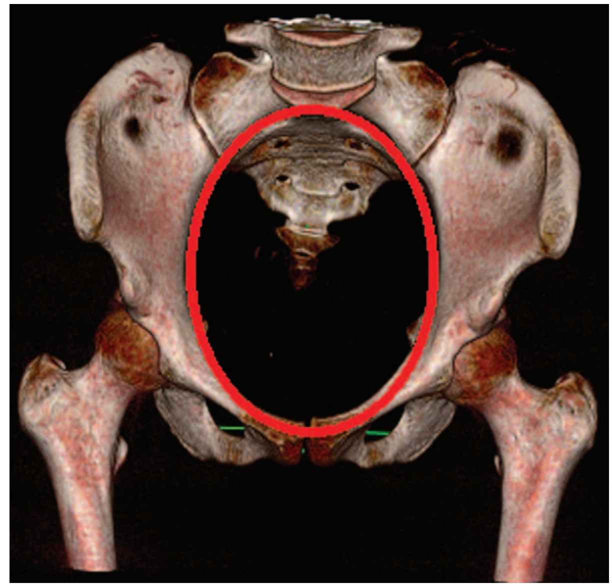

Figure 3. One of the 22 anthropoid type pelvis using 3-dimensional computed tomography.

osteotomy, which were easy to attract the attentions from orthopedists and obstetricians.

It is known to all that dystocia is an important issue in the obstetric delivery, whose relevant factors are effective uterine contraction, birth canal, and fetal size.[17] As to GMC women, the bony birth canal is the most important one. Normally, in obstetrical clinics, pelvic measurements aim to assess whether the pelvic cavity is sufficient for the average size of the fetus to pass. During clinical pelvic measurements, the doctor does not inspect the bone structures covered with pelvic soft tissue; the measured pelvic data are accepted as an approximation.[18] However, pelvic morphology is a crucial factor which has been used to assess women at risk of dystocia because of the cephalopelvic disproportion or contracted pelvis for many years.[19] Lots of countries, including China, have completed the epidemiologic investigation and data collection for their native female pelvis. Apart from manual evaluation, although X-ray pelvimetry shows some superiority, the shooting angle, the inherent blind area, and the restriction of planar photograph information limit its clinical application. Hence, Federle et al[20] 1st reported CT pelvimetry for female in 1982. In 2003, Balleyguier et al[21] 1st reported CT 3D reconstruction and measured some pelvis diameters. They pointed that 3D CT could not only be observed in every direction and measured accurately, but also more easily to be understood by obstetricians and midwives. In China, Liu pioneered this method to measure normal female Chinese, moreover, Liao et al used 3D MRI pelvimetry methods to establish the pelvimetric reference in Chinese females at term pregnancy.[22] However, there has been no correlational research pay any attention to patients with GMC which occupy the largest part of acquired pelvic malformation in China.

To summarize our research, in the 1st place, making a simple and quick diagnosis of GMC is necessary. In other words, the dysfunction of squatting with 2 legs together, the malfunction of crossing legs in sitting position, and the snapping around the greater trochanter are the 3 typical diagnostic criteria of GMC which should be understood. In the 2nd place, most GMC women have the anthropoid pelvis and their biischial diameters are much smaller than normal Chinese. Therefore, it is quite important that the obstetrician should adjust the fetal position to the pelvic type. In general, occipitoanterior and occipitoposterior position are more suitable than occipitotransverse position for anthropoid type. Furthermore, it was reported that interspinous diameter (equal to *biischial diameter*) was the best predictor of head descent, mode of delivery and obstructed labor in

Table 2

The comparison with literature data from Liu's study[14] (2-sample t test).

	Samples, n	Transverse diameter of the pelvic inlet, mm	Conjugate vera, mm	Diagonal conjugate, mm	Biischial diameter, mm	Anteroposterior diameter of the middle pelvis, mm	Transverse outlet, mm	Posterior sagittal diameter of outlet, mm	Conjugate of the outlet, mm	Anterior sagittal diameter of the outlet, mm	Curvature of the sacrum, degree	Length of the sacrum, mm	Angle of pubic arch, degree
GMCs	25	120.9±7.0	133.5±8.0	140.3±9.2	95.6±9.3	125.3±12.7	93.3±9.9	83.9±12.1	121.1±11.0	59.7±7.0	148.8±13.5	107.5±8.6	88.7±9.3
Literature participants	109	126.8±7.2	122.4±8.3	135.1±9.6	105.0±7.9	119.2±8.0	121.8±10.6	55.6±9.0	111.3±8.0	unavailable	141.7±12.2	109.4±10.31	88.2±8.3
		$t=3.714$ $P<.001$	$t=6.07$ $P<.001$	$t=2.416$ $P<.05$	$t=5.187$ $P<.001$	$t=3.044$ $P<.01$	$t=12.268$ $P<.001$	$t=13.241$ $P<.001$	$t=5.125$ $P<.001$	– –	$t=2.572$ $P<.05$	$t=0.856$ $P>.05$	$t=0.266$ $P>.05$

GMCs = gluteal muscle contractures.

comparison to other pelvic and fetal head parameters.[23] Hence, when engaging GMC women who have the smaller biischial diameter compared to Chinese minimum standard (95 mm) of natural delivery,[24] cesarean delivery should be put on the preoperative schedule.

5. Conclusion

In spite of these shortcomings, these results systematically present the reference indicators for the primary plane of the female pelvis in GMCs using the 3D CT pelvic measurement. In women with GMC, most pelvises had features of anthropoid pelvis which were quite different from normal Chinese female and need to be considered in obstetric decision-making. In a word, these findings conduce to the knowledge supporting the usefulness of precise pelvimetry both in orthopedists and obstetric practice in GMC cases.

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