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Radiographic signs of retroversion of acetabulum in adult Indian population, retrospective observational study

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Abstract

Introduction: Hip joint is commonly affected by osteoarthritis in Indian population and incidence of pain in hip and osteoarthritis is increasing in Indian population also. Retroversion of acetabulum is a type of hip dysplasia and a common cause of hip pain and Osteoarthritis of hip. Radiographic Diagnosis of the retroversion of Acetabulum is based on three signs: cross over sign (COS), posterior wall sign (PWS), prominent ischial spine sign (PRISS). All these signs are well described in literature and most of the Orthopedic surgeons don't know the significance of these signs.

Method: We evaluated 372 normal adult radiographs of pelvis from our radiology department to find out the prevalence of these signs in our hospital population. We also correlated the crossover ratio (percentage of crossover) to the presence of other two signs. In 372 normal pelvis radiographs 744 hips were analyzed for presence or absence of these 3 signs and the measurement of crossover ratio was done in AGFA workstation.

Results: The prevalence of COS is 17.7%, PWS is 7.3%, PRISS is 23.4%, and all 3 signs are present in 4.4% hips. Radiographs with only COS were 46 hips and the mean crossover ratio is 18.61%; while mean crossover ratio in 33 hips with all 3 sign positive was 21.95% which is statistically high.

Conclusion: Thus Higher crossover ratio is associated with PRISS and PWS positive hips. Higher values of crossover ratio is associated with PRISS sign.

Keywords: Hip osteoarthritis, radiography, hip dysplasia, prevalence, workstation

1. Introduction

In normal pelvis it is known that the acetabulum is oriented slightly facing anteriorly in a coronal plane called as ante version of acetabulum normally it is 18.2 degrees^[1] as studied in Indian literature; but there have been lot of research on ante version angle of acetabulum. If the acetabular opening is oriented posteriorly in coronal plane, it is known as retroversion of acetabulum which is a type of dysplasia of the pelvis bone^[2] which is also very well studied both in western countries^[3, 4] but less in India. Retroversion of acetabulum is a cause of hip pain which is far more common cause than thought because of unawareness of this entity or inability to diagnose it^[5] and patients may present early or late in young age.

Prevalence of the retroversion of acetabulum is 6%^[6] in normal group in American population and 48%^[7] in UK population. No Indian literature is available on prevalence in Indian population.

Also the retroversion is calculated and quantified on CT scan with accuracy with horizontal acetabular cross section^[2] and is used in most of the cases where diagnosis is confirmed.

But positioning of patient leads to some error in radiographs and CT scan also. Though CT scan is not the first investigation of choice as it involves cost and radiation hazard. Radiographic signs of acetabulum retroversion can be easily identified and can be given a grading by crossover ratio which can help to grade the severity of retroversion^[8].

On a plane pelvis radiographs there are 3 signs; the Crossover sign (COS), posterior wall sign (PWS), prominent ischial spine sign (PRISS) well described by Clément M.L.^[8] and other studies^[9] though there is substantial inter observer and intra observer variability in these signs. Posterior wall sign is described by Reynolds *et al.*^[10] is characterized by posterior wall

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covering the femoral head. If the centre of femoral head lies at or lateral to the border of posterior wall; then PWS is negative.

PRISS was described and introduced by Kalberer *et al.* [11]. If the ischial spine projects into the pelvic brim then it is PRISS sign positive. And they demonstrated the correlation between positive PRISS sign and the true retroversion of acetabulum. Aim of this study is to find out the prevalence of all 3 signs and correlation between the cross over ratio and any or all 3 signs.

2. Materials and Methods

We studied 372 pelvis radiographs (744 hips) from Radiology department of our Hospital from the month of September, October, November 2017. This is unicentric, retrospective, observational study.

2.1. Inclusion Criteria

Pelvis Radiographs are selected on following criteria- complete pelvis with proximal femur upto lesser trochanter visible, both greater trochanter equal and in profile, vertical line through coccyx tip and symphysis pubis less than 5mm (non-rotated radiograph), tip of coccyx should be within 3cm of symphysis, fused physis, Lines of posterior acetabular margin and anterior acetabular margin are well appreciated on radiograph. To summaries all 3 signs should be clearly classified and appreciated on radiograph.

2.2. Exclusion criteria

Hips showing arthritis or any pathology of hip or fracture or healed fracture, immature skeleton radiographs, Lines of posterior acetabular margin and anterior acetabular margin are not well appreciated on radiograph or inability to define any of the 3 signs are not considered in our study.

2.3. Defining signs and measurements

These radiographs are studied for 3 signs and a ratio was calculated. The presence or absence of cross over sign (COS), posterior wall sign (PWS), prominent ischial spine sign (PRISS) was noted and Crossover ratio was calculated if Cross over sign is positive.

2.3.1. Crossover sign is noted positive if the posterior acetabular line and anterior acetabular line crosses each other to form a figure of eight. If this two lines do not cross each other then COS is noted negative. This lines cross at a point and the distance of that point from the acetabular margin divided by transverse acetabular line length is known as crossover ratio which is a good quantitative parameter to quantify COS and indirectly quantifying retroversion of acetabulum and is used in previous studies also. This ratio is multiplied by 100 to express this ratio as a percentage for ease of understanding.

2.3.2. PWS is noted positive if the centre of head of femur lies lateral to posterior acetabular line. If the centre of head of femur lies at or medial to posterior acetabular line then the PWS is noted negative.

2.3.3. PRISS is noted positive if ischial spine is seen projecting in to the pelvic brim. If the ischial spine is seen within the pelvic brim shadow then it is noted as negative. Data of all three signs and crossover ratio is calculated on a AGFA workstation in the radiology department itself and the values entered in Microsoft excel sheet. We used freely

available Open Epi to do standard calculations. T test for equality of means was applied to calculate the significant value of Crossover ratio in a particular sign.



Fig1: True size, well focused, centralized AP radiograph of Pelvis.



Fig 2: Calculation of COS ratio on AGFA workstation. COS ratio= $0.77\text{Cm} / 4.69\text{Cm} = 0.1641 = 16.41\%$.



Fig 3: Demonstration of COS and PWS. COS on right is negative but on left is positive (anterior and posterior acetabular margins crossing each other forming figure of eight). Also note that PWS is positive on left but negative on right.



Fig 4: PWS positive on AGFA workstation.



Fig 5: Demonstration of PRISS. PRISS SIGN positive on both sides, Ischial spine projecting into pelvis brim.

3. Results

Table 1, 2, 3 summarizes results of our study. Prevalence of COS is 17.7%, PWS is 7.3%, PRISS is 23.4% of hips. Prevalence of all 3 signs together is 4.4% of hips. All these signs are independent of each other.

We also analyzed COS ratio in these hips (Table 2). Mean crossover ratio in hips with only COS positive hips (rest 2 signs negative) (n=46) is 18.61%, while in COS positive hips (n=132) is 21.368%. Mean crossover ratio in COS+ PWS positive hips (n=35) is 21.6922% which is higher than that of COS positive hips. Mean crossover ratio in COS+ PRISS positive hips (n=84) is 22.973%, which is more than that in COS+ PWS positive hips. Mean crossover ratio in COS+ PRISS positive but PWS negative hips (n=51) is 23.633%, which is highest in any group suggesting that higher crossover ratio is associated strongly to PRISS.

Mean crossover ratio was also compared in groups of PWS (PWS positive and negative) (Table 3). The group with PWS positive and COS positive hip had mean crossover ratio of 21.69%; while group with PWS negative and COS positive hips had mean crossover ratio of 21.251%. Mann Whitney test showed no statistical difference in these 2 groups suggesting crossover ratio is uniformly distributed in the groups of PWS.

On the other hand PRISS groups (PRISS positive and PRISS negative) showed difference (Table 3). In PRISS positive + COS positive hips mean crossover ratio is 22.973% which was statistically higher (p value= 0.001) than mean crossover ratio of 18.56% in PRISS negative + COS positive hips (Table 3).

Table 1: Prevalence of all the signs of retroversion of acetabulum.

Signs	Frequency	Percentage (%)
COS positive	132	17.7
PWS positive	54	7.3
PRISS positive	174	23.4
All 3 positive	33	4.4
COS and PWS positive	35	4.7
COS and PRISS positive	84	11.3
PWS and PRISS positive	45	6.0
n= 744		

COS= Cross over sign, PWS = Posterior wall sign, PRISS = Prominent Ischial spine sign.

Table 2: Relationship of mean crossover ratio to the signs of retroversion.

Sign	Mean cross over ratio
COS positive(n=132)	21.3683%
COS+ PWS positive(n=35)	21.6922%
COS+ PRISS positive(n=84)	22.973%
COS+PWS+PRISS positive(n=33)	21.951%
COS positive; PWS,PRISS negative(n=46)	18.61%
COS positive;PWS positive , PRISS Negative(n=2)	17.41%
COS and PRISS positive, PWS negative(n=51)	23.633%

Table 3: Shows distribution of COS ratio is uniform in hips with PWS positive or negative. But COS ratio is significantly associated with PRISS positive radiographs than PRISS negative radiographs.

	Mean cross over ratio	Significance
PWS positive + COS positive	21.6922%	No
PWS negative + COS positive	21.251%	
PRISS positive + COS positive	22.9730%	Yes. (p= 0.001)
PRISS negative + COS positive	18.560%	

4. Discussion

COS was present in 17.7% hips in our study; which can be the prevalence of retroversion of acetabulum in Indian population. While same was 48% [6] in western studies. This suggests that prevalence is much less in Indian population. These radiographic signs of retroversion of acetabulum is well studied in western literature. Clément M.L. in his study in Baltimore, U.S.A. in 2010 [8], studied the PRISS and PWS in only COS positive patients while we studied all 3 signs independently. We compared our results with this study in following para and also Table 4.

Prevalence of COS alone positive hips was 34.84% of all COS positive hips while Clément study had 31.7% hips. Similarly COS and PWS hips were found in 26.51% of COS positive hips (31% hips in Clément study). COS and PRISS positive hips were found in 63.63% of COS positive hips as that of 61.7% COS positive hips in Clément study. COS & PRISS & PWS positive hips were 25% in our study while 24.4% in Clément study. COS & PRISS alone positive hips were 38.63% in our study while the same as 37.3% hips in Clément study. While COS & PWS alone positive hips were 1.52% in our study and 6.6% in Clément study. This suggests that PWS is strongly associated with PRISS in COS positive hips; as out of 35 COS+ PWS positive hips only 2 were not having PRISS sign positive.

The crossover ratio and it's percentage was also studied in different groups of hips. In COS positive (n=132) hips the mean crossover ratio was 21.3683% while in COS alone positive hips it was 18.61% which is quiet low than in COS positive hips.

In COS positive hips, PWS positive hips had mean crossover ratio of 21.6922% while PWS negative hips had mean crossover ratio of 21.251% which shows that crossover ratio is equally disturbed in categories of PWS. (Mann Whitney U test)

In COS positive hips, PRISS positive hips had mean crossover ratio of 22.97% while PRISS negative hips had mean crossover ratio of 18.56% which shows that crossover ratio is not equally disturbed in categories of PRISS.(p value =0.001)

Table 4: Comparison between our study and western study.

Sign/ parameter	Our study COS positive hips (n=132) is considered 100% for comparison	Clément M.L. COS positive hips (n=1350) is considered 100% in study
COS alone	34.84% hips; mean COS ratio 18.61%	31.7% hips; mean COS ratio of 20.5%
COS & PWS positive	26.51% hips; mean COS ratio 21.6922%	31% hips;
COS & PRISS positive	63.63% hips; mean COS ratio 22.973%	61.7% hips;
COS & PRISS & PWS positive	25% hips; mean COS ratio 21.951%	24.4% hips; mean COS ratio 32.3%
COS & PWS alone positive	1.515% hips; mean COS ratio 17.41%	6.6% hips; mean crossover ratio 25.1%
COS & PRISS alone positive	38.63% hips; mean COS ratio 23.633%	37.3% hips; mean crossover ratio 25.9%

5. Conclusion

Prevalence of COS (thereby retroversion of acetabulum) in Indians is 17.7% which is less than half of that of western population.

But distribution of PWS and PRISS signs in those COS positive hips are comparable to western population.

Crossover ratio has higher values in western population than in Indian.

Higher values of Crossover ratio is associated with PRISS sign.

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