Original Research Article

Biometric Assessment of Superior Gluteal Neurovascular Bundle to Acetabulum of Hip Joint

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ABSTRACT

Introduction: The superior gluteal nerve (SGN) is a branch of sacral plexus with root value of L4, L5 and S1. It leaves pelvic cavity through greater sciatic foramen along with superior gluteal artery above piriformis. This neurovascular bundle lies in close proximity to superior acetabular rim. Iatrogenic damage to SGN is common during hip arthroplasties and may be primarily attributed to inappropriate placement of retractors. Alarmingly high percentage of affected individuals are stuck with persistent irreversible damage to SGN. Vascular injuries are not as common but pose a challenging scenario to surgeons. Hence in both situations prevention is of supreme importance. Precise knowledge of course and relation of superior gluteal neurovascular bundle (SGNVB) to clinically useful landmarks such as the superior rim of acetabulum is desired. With an aim to provide baseline data for the Indian population we conducted this study.

Material and methods: 200 dry adult Indian hip bones {Left side -109(male:66, female:43); Right side-91(male:66, female:43)} were photographed in anatomical position. Two lines- line A and line B were drawn. Line A corresponded to a horizontal passing through the anterior inferior iliac spine (AIIS) and roof of GSN while line B passed tangentially through the highest point on the acetabular rim parallel to line A. The vertical distance (white line) between the 2 lines was measured (Fig.2) using Image J software.

Results: The mean distance calculated was 0.62 ± 0.16 cm (0.68 ± 0.38 cm in right hip bones and 0.60 ± 0.30 cm in left side hip bones). The difference between the two sides and the two genders were compared and found to be statistically non-significant.

Conclusion: A safe zone of 0.5 to 0.7 cm beyond the superior acetabular rim should be considered during surgeries around hip joint. The safe zone can be easily measured by the surgeons intraoperatively and be used as a guide to careful positioning of the retractors while performing surgeries around the hip joint. Better localization of SGNVB using the anatomic landmark defined in this study may be used to decrease surgical morbidity.

KEY WORDS: Superior Gluteal, Acetabulum, Hip Joint, Total hip arthroplasty, Safe Zone.

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INTRODUCTION

The superior gluteal nerve (SGN) is formed by the dorsal branches of the ventral rami of L4, L5 and S1 nerve roots in the lesser pelvis. It leaves the pelvic cavity through the roof of the greater sciatic notch (GSN) above the piriformis muscle along with the superior gluteal artery (SGA) to enter the gluteal region. Here the neurovascular bundle lies between the gluteus medius and minimus muscle. The SGN then divides into superior and inferior branches while the SGA divides into superficial and deep branches. The deep branch of the artery further bifurcates into an upper and a lower branch. The superior branch of the nerve runs with the upper branch of the deep division of the artery to supply gluteus medius. The inferior branch of SGN accompanies the lower branch of the deep division of the SGA across gluteus minimus. It supplies the gluteus medius, gluteus minimus and tensor fasciae lata muscle. The superficial branch of the artery courses deep to the gluteus maximus and supplies it (Fig. 1). The superior gluteal neurovascular bundle (SGNVB) in the gluteal region lies in close proximity to the superior rim of the acetabulum at a variable distance [1].

Prevalence rate of neurologic injury after primary hip arthroplasty is estimated as 0.7- 3.5% and as 7.6% after revisional hip arthroplasty [4]. This data however primarily reflects the incidence of injury to sciatic nerve. There is paucity of data specifying the individual incidence of injury to SGN. This may be due to under reporting by patients, as there is absence of any sensory loss and attributing the abductor weakness to mechanical rather than to neurological deficit[5]. Clinical examination in such cases may underestimate nerve injury after THA[6]. This is further supported by an alarmingly high incidence of subclinical gluteal nerve injury in 77% patients undergoing THA[7]. In addition to this, about 80 % of patients who sustain a THA-related nerve injury have persistent neurologic dysfunction, including paraesthesia, neuropathic pain, or motor weakness[8]. Such injuries have severe effects on patients' prognoses and reduce their quality of life[9]. Thus prevention is the first principle in managing nerve injuries associated with THA[3]. In order to preserve the SGN during THA, the surgeons must have a sound knowledge of its course, relation and distance to clinically useful landmarks such as the superior rim of acetabulum.

Superior gluteal artery injuries are relatively uncommon during hip arthroplasties however they are a common complication during pelvic fractures. Pseudoaneurysms in SGA have been reported with injuries during pelvic surgeries and intramuscular injections [10,11,12,13]. Anatomical details regarding the course of the artery and its relation to prominent bony landmarks will help surgeons in rapid localization of such vessels.

With an aim to provide baseline data for the Indian population to assist the surgical scenario we conducted this study.

MATERIALS AND METHODS

The study was conducted on 200 dry adult hip bones {Left side -109(male:66, female:43); Right side-91(male:66, female:43) obtained from the osteological museum of the Department of Anatomy at Maulana Azad Medical College. Sexing of skulls was documented through the museum catalog. Hip bones exhibiting...
obscuting pathologies such as bone deterioration were excluded from the study. Photographs were taken keeping the bone in anatomical position, that is, with the anterior superior iliac spine (ASIS) and the pubic tubercle in the same coronal plane along with a measuring scale using Nikon D3300 DSLR camera. Image J software was used to do the measurements. Two lines- line A and line B were drawn. Line A corresponded to a horizontal passing through the anterior inferior iliac spine (AIIS) and roof of GSN while line B passed tangentially through the highest point on the acetabular rim parallel to line A. The vertical distance (white line) between the 2 lines was measured (Fig.2). This distance was recorded and the values tabulated for all the bones.

Statistical analysis was done using the Statistical Package for the Social Science (SPSS version 20). Student T test was used to compare results between sides and gender. Statistical significance was set at p< 0.05.

The mean distance calculated was 0.62 ± 0.16 cm (0.68 ± 0.38 cm in right hip bones and 0.60 ± 0.30 cm in left side hip bones). The values were different in male and female hip bones of right and left sides. The distance in male hip bones of right side was measured as 0.70 ± 0.41 cm and in females was 0.57 ± 0.34 cm. The distance in male hip bones of left side was measured as 0.61 ± 0.30 cm and in females was 0.55 ± 0.32 cm(Table 1, Graph 1,2)). These differences between the two sides and the two genders were statistically non-significant (Table 1).

Table 1: Showing the measured distances in both sides and gender.

| Side          | Mean distance (right) | Mean distance (left) | p value |
|---------------|------------------------|----------------------|---------|
| Right Male    | 0.70 ± 0.41 cm         | 0.61 ± 0.30 cm       | 0.09    |
| Right Female  | 0.57 ± 0.34 cm         | 0.55 ± 0.32 cm       | 0.46    |
| Left Male     | 0.62 ± 0.16 cm         | 0.68 ± 0.38 cm       |         |
| Left Female   | 0.57 ± 0.34 cm         | 0.55 ± 0.32 cm       |         |

Graph 1: Showing comparison between the right and left side hip bones.

Graph 2: Showing the comparison between right and left sides of male and female hip bones.

DISCUSSION

Injury to the SGN would lead to the paralysis of the gluteus medius, gluteus minimus and the tensor fascia lata muscles which would
superior rim of the acetabulum. This study was based on MRI scans of 263 Chinese patients[3]. They reported the distance to be 2.23±0.28 cm. This distance as per the present study on dry adult bones of Indian origin is much less (0.62 ± 0.16 cm). This may be attributed to the topographical differences between the two study populations. Based on this we can specify a safe zone of 0.5 to 0.7 cm beyond the superior acetabular rim for surgeries around the hip joint. Thus we can conclude that in Indians, this safe zone is less and margin of error during surgeries is very small.

In a study by Solomon et al.[23], on 50 dry bones the mean distance between AIIS and acetabular rim in males was 1.13 ±0.31cm and in females was 0.96 ±0.45 cm whereas in the present study the mean distance recorded is male hip bones: 0.7±0.41cm (right); 0.61±0.3 cm (left); female hip bones: 0.57±0.34cm (right); 0.55±0.32 cm (left). This differences in measurements could be attributed to mixed population used by Solomon et al which included Europeans, Asians along with Indians. The Europeans and Asians have greater dimensions as compared to Indians as shown in previous studies on Germans[24] and Chinese[3].

Guy P et al.[24], measured the same distance on 93 CT Scans and came to the conclusion that the safe zone during acetabular surgeries in relation to sciatic notch was 1.1 cm. However according to the present study this safe zone should be reduced further. A study by Amar E et al.[25], on CT Scans of 50 patients without any hip pathology concluded that no significant difference exists between the

| S.no | Study                  | Year       | Population          | Sample size | Bony Reference used                        | Distance measured | Type of study                      |
|------|------------------------|------------|---------------------|-------------|-------------------------------------------|-------------------|-----------------------------------|
| 1    | Jacobs and Buxton      | 1989       | British             | 10 cadavers | Centre of superior border of the greater trochanter | 5 cm              | Cadaveric study                   |
| 2    | Bos et al              | 1994       | Netherlands         | 20 cadavers | Tip of greater trochanter                 | 3 cm              | Cadaveric study                   |
| 3    | Baker and Bitounis     | 1989       | British             | 68 hips     | Tip of the greater trochanter             | Anterior: 3 to 5 cm, Posterior: 6 to 8 cm | Clinical and electromyographic study |
| 4    | Eksioglu et al         | 2002       | Turkish             | 12 cadavers | Greater trochanter                        | Anterior: 2.7 cm, Posterior: 4.6 cm | Cadaveric study                   |
| 5    | Wang et al             | 2016       | Chinese             | 263 MRI scans | Superior rim of the acetabulum            | 2.23±0.28 cm      | Radiological study                |
| 6    | Solomon et al          | 2013       | Indian, European    | 50 dry bones | Superior rim of the acetabulum            | Males: 1.13 ±0.31cm, Females: 0.96 ±0.45 cm | Dry bone study                   |
| 7    | Guy P et al            | 2010       | German              | 93 CT Scans | Superior rim of the acetabulum            | 1.1 cm            | Radiological study                |
| 8    | Amar E et al           | 2013       | Israeli             | 50 CT Scans  | Superior rim of the acetabulum            | 1.35 cm           | Radiological study                |
| 9    | Present study          | 2017       | Indian              | 200 dry bones | Superior rim of the acetabulum            | 0.62 ± 0.16 cm    | Dry bone morphometry              |
distance measured on the basis of side or gender in their Israeli study population as also seen in the present study.

This study provides gender and side dependent estimate of a safe area for SGN during surgeries around the hip joint. The side differences are minimal. The values recorded on male hip bones were slightly more than that on female hip bones however the difference was not statistically significant. Nevertheless these gender differences should be borne in mind while performing surgeries. These measurements will also be of help to surgeons in swift exploration for injured SGA during pelvic surgeries or pelvic fractures. Better localization of SGNVB using the anatomic landmark defined in this study may decrease surgical morbidity.

CONCLUSION

We propose a safe zone of 0.5 to 0.7 cm beyond the superior acetabular rim for surgeries around the hip joint. The safe zone can be easily measured by the surgeons intraoperatively and be used as a guide to careful positioning of the retractors while performing surgeries around the hip joint. The gender variability should also be borne in mind during surgeries. This could bring down the incidence level of iatrogenic damage to the superior gluteal neurovascular bundle. In near future we aim to supplement this data from dry bones with cadaveric measurements to provide a holistic anatomical knowledge to the surgeons.

Conflicts of Interests: None

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