# Safe zone for the superior gluteal nerve in the transgluteal approach to the dysplastic hip

## Intraoperative evaluation using a nerve stimulator

Masahiko Ikeuchi, Teruhiko Kawakami, Norio Yamanaka, Yusuke Okanoue and Toshikazu Tani

Department of Orthopaedic Surgery, Kochi Medical School, Kochi University, Nankoku, 783-8505 Japan
Correspondence MI: ikeuchim@med.kochi-u.ac.jp
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**Background** **The superior gluteal nerve can be damaged during the transgluteal approach to the hip in total hip arthroplasty.**

**Methods** **We studied 30 patients with hip dysplasia who underwent total hip arthroplasty through the transgluteal approach. The course of the inferior branch of the superior gluteal nerve was identified using a nerve stimulator. The distance between the nerve and the tip of the greater trochanter was measured.**

**Results** **The mean distance was 37 (25–45) mm at the anterior third, 40 (30–50) mm at the middle third, and 44 (35–55) mm at the posterior third of the gluteus medius. The distance was influenced by the severity of hip dysplasia and decreased as the degree of hip dysplasia became more severe.**

**Interpretation** **A 3-cm safe zone is appropriate in most dysplastic hips. In severely dysplastic hips, however, the superior gluteal nerve occasionally coursed within 3 cm of the tip of the greater trochanter. In such hips, a nerve stimulator can be used to identify the nerve.**

The transgluteal approach to the hip (Bauer et al. 1979, Hardinge 1982) is widely used because it gives excellent exposure of the joint, with a low rate of postoperative dislocation. The superior gluteal nerve (SGN) can be damaged during the transgluteal approach, however, leading to abductor dysfunction. Clinical and electromyographic studies have shown that SGN damage is not uncommon during hip surgery (Baker and Bitounis 1989, Abitbol et al. 1990, Ramesh et al. 1996, Kenny et al. 1999, Siebenrock et al. 2000). To avoid this complication, several authors have reported a safe zone for the SGN (Nazarian et al. 1987, Jacobs and Buxton 1989, Bos et al. 1994, Duparc et al. 1997, Perez et al. 2004). The safe zone is the distance between the inferior branch of the SGN and the tip of the greater trochanter (TT), within which the gluteus medius can be split without causing nerve damage. However, problems can arise when we apply the safe zone in clinical settings. According to previous reports, the safe zone varies from 2 to 5 cm and all of these reports were based on cadaveric studies—presumably without dysplastic hips. Since one would expect that the safe zone in the dysplastic hip may be shortened, we investigated the safe zone for the SGN in the transgluteal approach to the dysplastic hip.

## Patients and methods

We studied 30 Japanese patients (21 women) with hip dysplasia who underwent primary total hip arthroplasty through the transgluteal approach between August 2003 and June 2005. All patients gave informed consent. Their mean age was 68 (52–86) years. Mean height was 1.51 (1.38–1.72) m. Mean body weight was 57 (41–82) kg. The severity of hip dysplasia, defined as the distance between the teardrop line and the head-neck junction divided by the pelvic height, was measured on the preoperative


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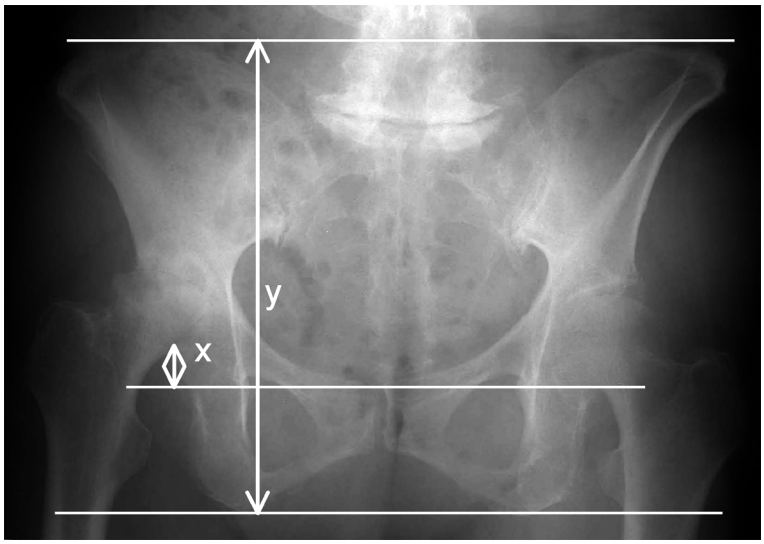


Figure 1. In Crowe et al. (1979), cranial displacement of femoral heads in dysplastic hips was measured as cranial displacement (x) of the medial head-neck junction from the tear drop line, and 100% subluxation of the femoral head was defined as cranial displacement of one-fifth of the pelvic height (y). Severity of hip dysplasia was defined as the cranial displacement of femoral heads (x) divided by the pelvic height (y).

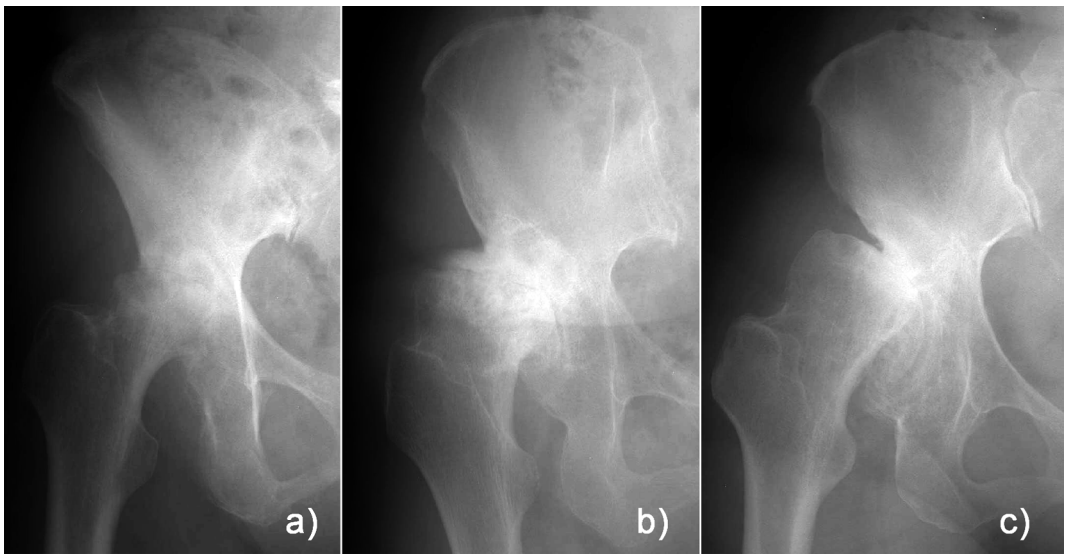


Figure 2. Crowe group I was defined as less than 50% subluxation (a), group II 50–75% (b), group III 75–100% (c), and group IV more than 100% subluxation of the femoral head.

anteroposterior radiograph of the pelvis according to Crowe et al. (1979) (Figure 1). 15 hips were in group I, 12 were in group II, and 3 were in group III (Figure 2). All procedures were performed in the lateral decubitus position. After the skin and the fascia lata were incised, both the anterior and posterior borders of the gluteus medius were exposed. 3 lines (anterior third, middle third, and posterior third) were drawn using a gentian violet surgical marker, with the width of the gluteus medius as a reference. We identified the course of the inferior branch of the SGN using an electric nerve stimulator (Neutracer; Top Corp., Tokyo, Japan). A Teflon-coated stimulation needle (Pole Needle 25G, 50 mm; Top Corp., Tokyo, Japan) was inserted into the gluteus medius at about 2–4 cm depth, just above the TT. The stimulator was set to deliver a 2-mA pulse at a frequency of 2 Hz. We moved the needle from distal to proximal, along the 3 lines, to find the point where the anterior portion of the gluteus medius contracted; and when found, the amplitude of the stimulator was turned down to 1 mA.

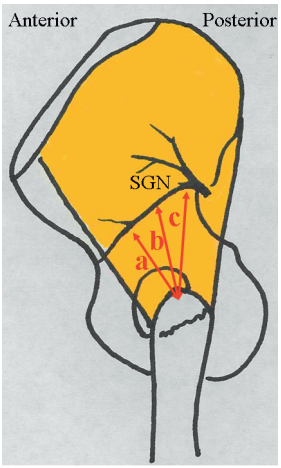


Figure 3. Location of the measurements. Distance between the inferior branch of the superior gluteal nerve and the tip of the greater trochanter was measured at (a) the anterior third, (b) the middle third, and (c) the posterior third of the gluteus medius. SGN: superior gluteal nerve.

We moved the needle, and the point which elicited maximum contraction of the muscle was considered to be the location of the inferior branch of the SGN. The distance between the nerve as identified by the stimulator and the TT was measured using a ruler at 5-mm intervals (indirect measurement) (Figure 3). All procedures to identify the course of the nerve using the stimulator were performed by a single observer (MI) and completed within 5 min.

In 10 of the 30 patients, we exposed the inferior branch of the SGN at the anterior third of the gluteus medius to evaluate the reliability of the measurement. This direct measurement of the distance between the inferior branch of the SGN and the TT was done using a ruler. We regarded the difference in the distance between the direct and indirect measurement as the measurement error. We observed the trunk of the inferior branch of the SGN close to the point determined by indirect measurement in all 10 patients; the measurement error was within 5 mm. The mean value of the error was 2.5 (SD 1.6) mm. The results of indirect measurement were always shorter than those of direct measurement.

### *Statistics*

We used analysis of variance followed by the Fisher protected least significant difference (PLSD), with $p < 0.05$ indicating statistical significance. We used multiple regression analysis to examine the relationships between continuous variables, including body height and the severity of hip dysplasia, and the distance between the inferior branch of the SGN and the TT.

## Results

The mean distance between the inferior branch of the SGN and the TT was 37 (25–45) mm at the anterior third, 40 (30–50) mm at the middle third, and 44 (35–55) mm at the posterior third. The branch ran slightly obliquely downward and forward and was located at a distance of 25–55 mm above the TT. The distance between the nerve and the TT was greater than 30 mm in all but 2 severely dysplastic hips (Crowe group III) at the anterior third of the gluteus medius. The distance between the nerve and the TT at the anterior third was shorter than that at the middle third and at the posterior third ($p = 0.02$ and 0.003, respectively). Regarding any correlation of body height and the severity of hip dysplasia with the distance between the nerve and the TT on multiple regression analyses, the severity of hip dysplasia showed a moderate inverse correlation with this distance (Table). Body height showed a poor correlation with the distance. These findings suggest that the distance between the nerve and the TT is influenced more by the severity of hip dysplasia than by body height. The distance between the nerve and the TT decreased as the degree of hip dysplasia became more severe.

## Discussion

To our knowledge, there have been no previous studies investigating the course of the SGN in the dysplastic hip. We found that the distance between the nerve and the TT varies with the severity of hip dysplasia. With a safe zone of 30 mm, we can safely perform surgery in most hips regardless of where the gluteus medius is split. However, the inferior branch of the SGN coursed within 30 mm above the TT at the anterior third of the gluteus medius in severely dysplastic hips (2 hips in group III). In these hips, we recommend splitting the posterior portion of the gluteus medius or the use of a nerve stimulator.

**Results of multiple regression analysis**

| | Anterior third | | Middle third | | Posterior third | |
|---|---|---|---|---|---|---|
| | SRC [a] | P-value | SRC | P-value | SRC | P-value |
| Body height | 0.037 | 0.7 | –0.051 | 0.7 | –0.053 | 0.1 |
| Severity of hip dysplasia | –0.69 | 0.003 | –0.56 | 0.04 | –0.32 | 0.1 |

[a] SRC: standardized regression coefficients

According to a small number of reports (Bos et al. 1994, Eksioglu et al. 2003), there is a significant correlation between body height and the distance between the SGN and the TT. It is to be expected that the SGN would course closer to the greater trochanter in patients with short stature. Most previous cadaveric studies have not reported the height of the cadavers. Although we found a poor correlation between body height and the course of the SGN, this may have been due to the small number of patients and the presence of hip dysplasia. We consider that particular care should be taken in patients with short stature.

Identification of the inferior branch of the SGN using a nerve stimulator (indirect measurement) was simple and reliable. We consider that measurement with less than 5 mm error is acceptable in clinical settings. The results of indirect measurement were always shorter than those of direct measurement. Thus, it could be safe for the nerve to split the gluteus medius according to the indirect measurement. However, we consider that identification of the nerve using a stimulator is not always necessary; surgery is safe in most dysplastic hips regardless of where the gluteus medius is split within the 30 mm safe zone. Identification of the nerve using a stimulator may only be useful in patients with severely dysplastic hips (i.e. Crowe group III and IV), since the nerve courses unexpectedly close to the greater trochanter in these patients.

### *Contributions of authors*

MI conception and design, data acquisition and analysis, manuscript writing and revision. TK conception and design, manuscript revision. NY data analysis, manuscript writing and revision. YO and TT data analysis, manuscript revision.

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