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Optimal trajectory and insertion accuracy of sacral alar iliac screws

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ABSTRACT

Objective: The aim of this study was to analyse the optimal trajectories for sacral alar iliac screws (SAISs) in a Japanese patient population and the clinical assessment of insertion accuracies.
Methods: The ideal trajectories of SAISs, starting from 2 mm medial to the apex of the lateral sacral crest on the midline between S1 and S2 dorsal foramina, were measured in 80 consecutive spinal disease patients (40 males and 40 females; average age: 67.4 ± 8.1 years) using three-dimensional computed tomographic image software. Following these anatomic analyses, accuracies of 32 inserted SAISs in consecutive patients, who underwent long spinal posterior fusion, were investigated clinically.
Results: Lateral angulations of optimal SAIS trajectories in males (left: 37.9; right: 37.7) were significantly larger than those than in females (left: 32.8; right: 32.4). Caudal SAIS angulations for females (left: 33.4; right: 33.9) were significantly larger than those in males (left: 27.5; right: 28.0). The 32 SAISs (100 mm long and 9 mm in diameter) assessed clinically were accurately inserted on optimal trajectories.
Conclusion: The optimal trajectories of SAISs in a Japanese patient population are more lateral in males and more caudal in females. This study examines the clinical safety and accuracy of SAIS insertion on these optimal trajectories.
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Introduction

For spine surgeons treating spinal deformity, spino-pelvic fixation remains a challenge despite numerous various instrumentation methods have been reported and developed.[1–3] Sacral alar iliac screw (SAIS) stated by Sponseller[4] is useful strong caudal anchor in long spinal posterior fusion to sacrum, and has many advantages as compared with conventional iliac screws.[4,5] In the original paper, starting point of SAIS is 1 mm inferior and 1 mm lateral to the S1 dorsal foramen, and trajectory is 40–50° angulation relative to the horizontal line and 20–30° caudal from straight lateral.[4,5] After that, previous reports have indicated various optimal entry points and trajectories of SAIS.[6–8] However few reports have indicated so far actual insertion accuracy in clinical practice, and ethnic difference of pelvic shape may affect the optimal trajectories of SAIS.

Our past research of the inserted 25 SAISs based on the method of the original paper for two years until 2012 in our hospital revealed low accuracy of 12% and particularly the 64% shorter screws than iliac narrowest point (Table 1). Based on this low accuracy, we investigated optimal entry point and trajectory of SAIS in a Japanese population using three-dimensional computed tomographic (3DCT) image software in this study. Furthermore, the trajectories of the consecutive inserted SAISs in clinical practice after the anatomic study were also evaluated.

Materials and methods

In the anatomic study, at first, 2 mm medial to apex of lateral sacral crest on midline between S1 and S2 dorsal foramen was chosen as the optimal entry point of SAIS using 3DCT image software (SYNAPSE VINCENT, Fuji Photo Film, Co. Ltd., Japan) based on the data of the inserted 25 SAISs until 2012 in our hospital (Fig. 1). The ideal trajectories of SAIS which started from this point with sufficient length and diameter were measured in consecutive 80 spinal disease patients (male: 40; female: 40; average age: 67.4 ± 8.1) who admitted to our hospital from April, 2012 for 6 months using 3DCT image software by an observer blinded to the

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Table 1
Accuracies of insertion of 25 SAISs from 2011–2012.

Number of SAIS	Out of total of 25
Medial breach of ilium	3 (12%)
Lateral breach of ilium	4 (16%)
Cut out of sacrum	20 (80%)
Shorter than iliac narrowest point	16 (64%)
Optimal insertion	3 (12%)

SAIS: sacral alar iliac screw.
This assessment of 25 SAISs inserted for two years prior to 2012, based on the methods and findings of the original papers,[4,5] reveals a low optimal insertion accuracy of 12% and, notably, 64% of the screws being shorter than the iliac narrowest point.

study (Fig. 2). The measurements in the transverse plane along SAIS trajectory were lateral trajectory angulation, maximal SAIS length and maximal intrailiac length (Fig. 3A). Caudal angulation was measured in the sagittal plane along SAIS trajectory (Fig. 3B). Iliac width at the narrowest point was measured in the coronal plane vertical to SAIS trajectory (Fig. 3C).

In the clinical study, secondly, 32 inserted SAISs in consecutive 16 spinal deformity patients (male: 6; female: 10; average age: 72.5 ± 9.6) underwent long spinal corrective posterior fusion to sacrum and pelvis (mean fusion levels: 8.4 ± 1.8) who admitted to our hospital from April, 2013 for 10 months based on the optimal trajectory obtained from results of the above anatomic study were investigated. Screw trajectory angulation, maximal screw length, intrailiac screw length, screw diameter and presence/absence of screw breach at sacrum and/or ilium were measured and investigated also using postoperative 3DCT image software (Fig. 4). Presence/absence of L5-S1 union and SAIS loosening of the all 16 patients were investigated on CT images at one year after surgeries.

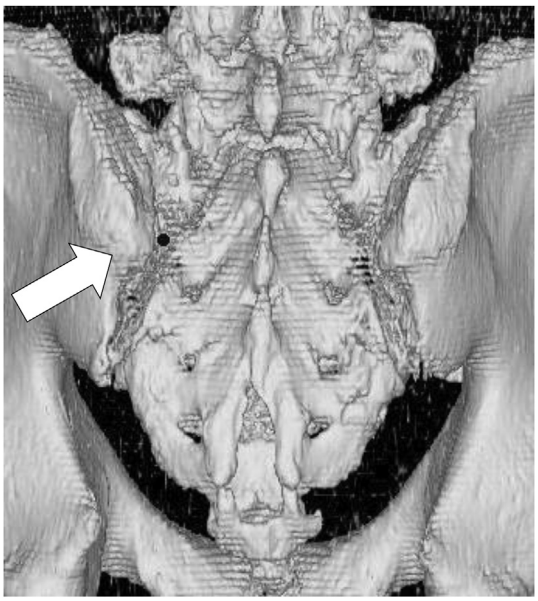

Fig. 1. Entry point of SAIS on 3DCT image. 2 mm medial to apex of lateral sacral crest on midline between S1 and S2 dorsal foramen (white arrow) was chosen as the optimal entry point of SAIS using 3DCT image software.

Values were expressed as mean ± standard deviation (SD). The mean values of trajectory angles, lengths and diameters of SAIS were analyzed using Student's *t*-test between left and right pelvis, and between male and female. A p value less than 0.05 was considered to be statistically significant.

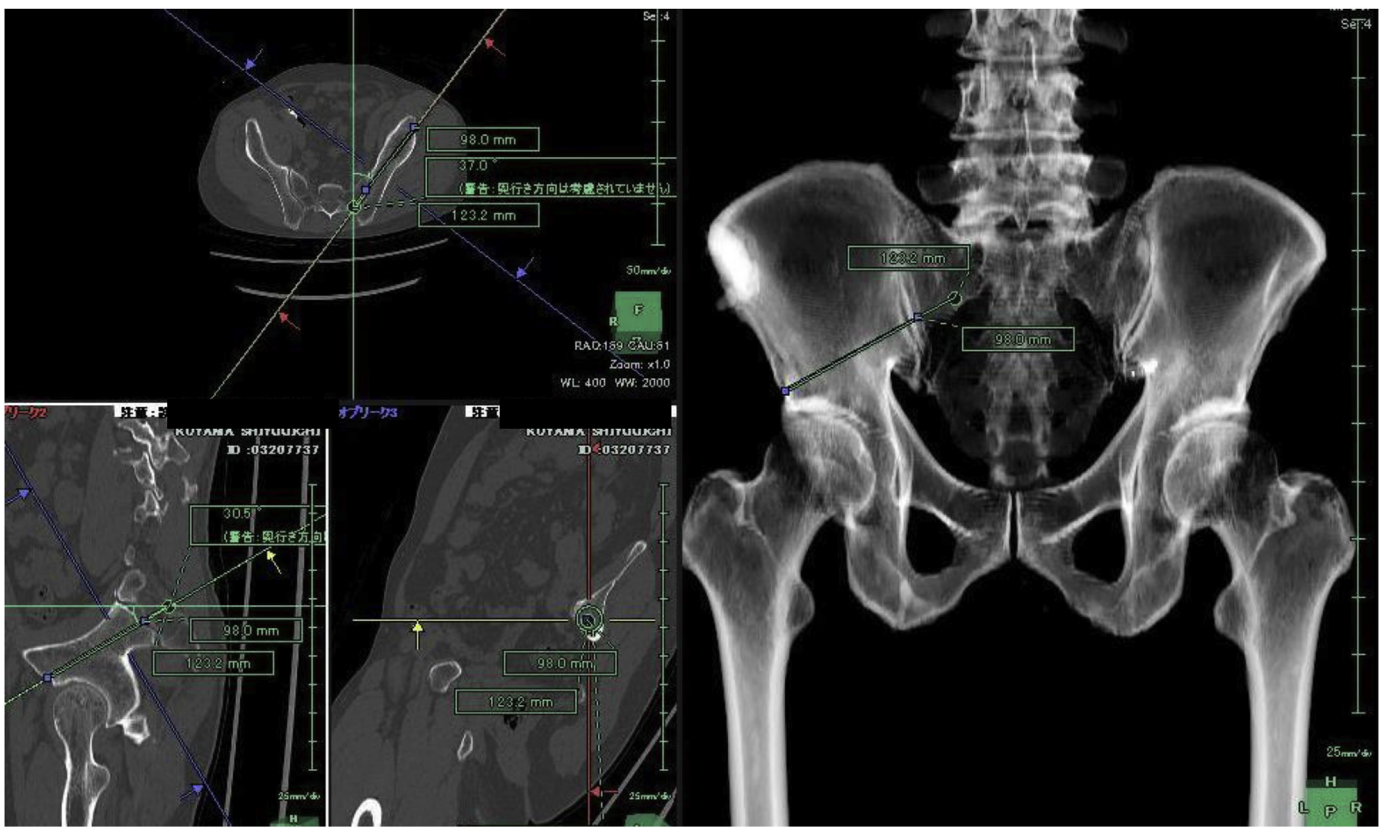

Fig. 2. The data of patient (male, 65 years) on 3DCT image software. Transverse, sagittal and coronal plane images on left side; 3D image on right side.

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