

# Early results of S2 alar - iliac (S2AI) fixation for long fusions for adult spinal deformity

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## Abstract

**Background:** Adult spinal deformity (ASD) is a degenerative condition that deviates the spinal axis, which can lead to pain, nerve damage, and/or loss of function. Surgical treatment is indicated when medical therapy fails to respond after 6 weeks. S2 alar-iliac (S2AI) fixation for long fusions is a method to treat ASD. This study aimed to evaluate the clinical improvement and full spine X-ray after surgery for ASD by fixing the lumbar thoracic spine with S2 sacroiliac joints, decompression, and lumbar interbody fusion. **Materials and method:** A retrospective study in patients treated by S2 alar-iliac (S2AI) fixation for long fusions between January 2018 to Dec 2021 in Viet Duc University Hospital.

**Results:** There were 15 cases identified. The mean age in the study was  $63.6 \pm 6.4$  years old, sex ratio was 1/14 (male/female). The improvement in preoperative SVA was 75.19 mm to 42.22 mm postoperative. There were significantly improvement in the quality of life of patients through the ODI index, questionnaire SRS-22 postoperative.

**Conclusions:** S2 alar-iliac (S2AI) fixation for long fusions provides safe and effective correction in the sagittal planes and improves postoperative quality of life.

**Keywords:** Adult spinal deformity, ASD, S2 alar-iliac, S2AI

## Introduction

Adult spinal deformity (ASD) describes a wide range of conditions that result in normal spinal alignment and may result in pain, disability neurological impairment, and/or loss of function. Such deformities can involve any combination of the axial, coronal, and sagittal planes. The prevalence of degenerative spinal deformity in adults increases from 1% to 30%. ASD can be treated surgically or non-surgically. The main goals of surgery are to decompress involved neural elements, realign in spine in coronal and sagittal planes based on indicators such as SVA, PT, PI... S2 alar (S2A) fixation for long fusions is a surgical correction of these deformities. At Spine Surgery Department in Viet Duc University hospital, we have performed S2 alar-iliac fixation for long fusions since 2018, but there has been no report on this surgery. Therefore, we conducted the study: "Early results of S2 alar-iliac fixation for long fusions for adults spinal derfomity" with the goal of evaluating the clinical and radiograph results of this method at Viet Duc University hospital.

## Materials and methods

A retrospective study in patients treated by S2 alar-iliac (S2AI) fixation for long fusions between January 2018 to Dec 2021 in Viet Duc University Hospital.

### Sampling:

Sample size: Convenience sampling.

### Inclusion criteria

Adult degenerative scoliosis.

No history of idiopathic scoliosis previously.

Patients are willing to participate.

### Exclusion criteria

Comorbidities such as spinal tuberculosis, sacral tumors, end stage liver diseases, end stage kidney diseases,...

Uncompleted information and data.

Patients are not willing to participate.

**Methods:** A cross - sectional quantitative, retrospective study.

## Surgical procedure:

The patient received intubation anesthesia.

Patient lies prone, abdomen free, hip flexed slightly.

Local anesthetic with a mixture of Adrenalin and Lidocaine to determine the location of the skin incision.

Incision of the skin, exposing the screws entry points of the vertebrae in segments, carefully stopping bleeding to avoid blood loss.

After exposing the screw entry points clearly, proceed to screw under the floro

Iliac S2 screw: The entry point is the midpoint of the S1-S2 conjugate hole 2 mm from the outer edge of the sacrum, using a 3 mm high speed burr drill to reveal the 5mm deep entry point. Screw S2 under the guide of C-arm.

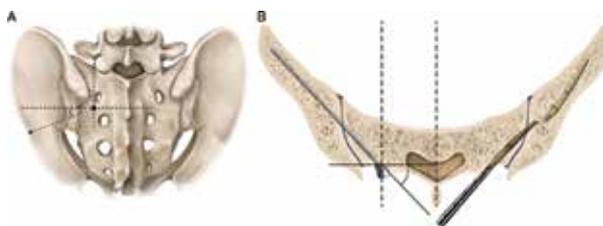


Figure 1: S2 screw entry point and trajectory [1]

S1 entry point:

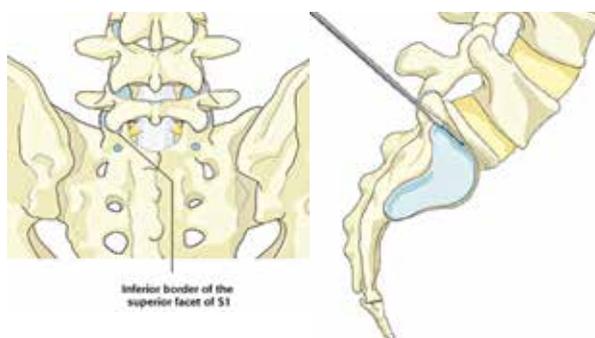


Figure 2. S1 entry point and trajectory

Pedicle screw at L5-T10 under floro.

Neurological decompress, osteomy, TLIF L3L4 L4L5 L5S1 (and L2L3).

Rod contouring, putting inner nuts.

Drainage, closure.

**Results**

**General characteristics:**

Age: The mean age was 63.66.4. The most ages distribution was at 60-70 (53.3%). Sex: 14 females patients (93.3%), 01 male patient (6.7%).

Clinical characteristics and radiograph index in preoperative:

**Preoperative VAS scores:**

Table 1: Preoperative VAS score

VAS	Lumbar VAS score (f)	Legs VAS score (f)
Means	6.87 ± 0.7	6.93 ± 0.7

**Classifications on X-ray**

Sagittal planes deformity

Table 2: SRS-Schwab Classifications in sagittal planes

	No of patients (n)	%
0: < 10°	0	0
+: 10 - 20°	4	26.7
++: > 20°	11	73.3
0: SVA < 4 cm	4	26.7
+: SVA 4 - 9,5 cm	7	46,6
++: SVA > 9,5 cm	4	26.7
0: PT < 20°	4	26.7
+: PT 20 - 30°	6	40.0
++: PT > 30°	5	33.3

**Post operative results:**

General operative statistics

Table 3: Operation statistics

Variable	Mean	Min	Max
Blood loss(ml)	1303.33 ± 484.69	700	2500
Operation duration (minutes)	300.5 ± 30.3	200	420
Hospital stays (days)	11.2 ± 9.2	5	39
No of fixation segments	10.5 ± 1.6	10	16
No of fusion levels	2.53 ± 0.83	1	4

**Post operative clinical characteristics:**

Table 4: Post operative VAS scores.

VAS scores	Lumbar VAS score (No of patients)		Legs VAS score (No of patients)	
	Pre-operation	Post-operation	Pre-operation	Post-operation
0	0	0	0	0
1-2	0	11	0	9
3-4	0	4	0	5
5-6	4	0	5	1
7-8	11	0	10	0
9-10	0	0	0	0
N	15	15	15	15
Mean	6.87 ± 0.7	2.33 ± 0.81	6.93 ± 0.7	2.73 ± 1.03
	p = 0.000		p = 0.001	

Table 5: Postoperative Radiographic measurements

Variables	Pre-operation	Post-operation	p
Thoracic kyphosis - TK (°)	9.03 ± 4.2	19.91 ± 6.42	0.001
Lumbar lordosis - LL (°)	9.81 ± 17.3	22.58 ± 8.23	0.007
PT (°)	25.1 ± 8.37	24.91 ± 5.48	0.943
PI (°)	41.87 ± 12.25	44.61 ± 10.51	0.452
PI-LL mismatch(°)	32.06 ± 13.76	22.03 ± 11.93	0.257
SVA (mm)	75.19 ± 37.42	42.22 ± 22.51	0.000

Table 6: ODI improvement

ODI (%)	Pre-operation	Post-operation	P
Medium	44,40 ± 5,68	22,40 ± 9,12	0,001
Min	27	16	
Max	51	52	

Table 7: SRS-22 improvement

SRS-22	Pre-operation	Post- operation	p
SRS - Function	1.49 ± 0.29	3.01 ± 0.75	0.000
SRS - Pain	2.27 ± 0.49	3.83 ± 0.49	0.000
SRS Self -image	1.39 ± 0.26	3.11 ± 0.74	0.001
SRS Mental health	2.69 ± 0.58	3.93 ± 0.60	0.000
Total SRS	0.75 ± 0.23	2.53 ± 0.60	0.000
SRS Satisfaction		4.23 ± 0.78	

### Surgical complications:

Table 8: Surgical complications

Complications	No. of Patients	%
Infections	2	13,3
Proximal Juntional Kyphosis	1	6,7
Total	3	20

### Discussion

In our study, female patients accounted for 93.3%, the female/male ratio was 14/1. The researches of the authors in the world also gave similar results as those of Alex S.Ha et al (2021) in a study on 83 patients, the percentage of women was 74.7%, [3] Smith et al (2018) studied at 86 patients from 2009 - 2014, the female rate was 79%.79% [4].In Vietnam, there is no research evaluating long-term fixation in ASD. The authors suggest that women have a higher rate of deformity due to the following reasons: heavy labor, high labor frequency, childbirth and pregnancy, osteoporosis. The mean age of the patients in our study was  $63.6 \pm 6.4$  years old. In the study by Alex S.Ha (2021), the mean age was 56.6 years,[3] by Ailon (2015), it was 70.5 [6] and in Smith study was 63.6 [4].According to Ailon, the rate of ASD is 1 - 30% and it was increased with

aging, 30% of patients 50 - 84 years old, our study gives similar results.

About VAS scores: In our study, the average lumbar VAS score in pre operation was  $6.87 \pm 0.7$ , the leg VAS scores was  $6.93 \pm 0.7$ . All patients had severe pain with VAS score of 7 - 8.

About ODI, 13 patients (86.7%) had a high degree of functional decline, the average ODI in our study was  $44.40 \pm 5.68\%$ . In the study of Alex S.Ha (2021), the author divided into 2 groups of patients with postoperative pain and no postoperative pain, the ODI of these two groups was  $44.6 \pm 13.7\%$  and  $38.6 \pm 18.5\%$ . [3]

According to our study, the blood loss was  $1303.33 \pm 484.69$  ml, the average surgical duration was  $300.5 \pm 30.3$  minutes. According to S. Ha, the average blood loss was  $1557 \pm 945$  ml, the average surgery duration was  $500 \pm 132$  minutes[3]. The surgery S2- iliac for long fusion is a major surgery, it was took a lot of time and much of blood loss, so it should be done in major medical center with high level of anesthesia and resuscitation. The number of fixation segment in our study was  $10.5 \pm 1.6$ , the fusion level was  $2.53 \pm 0.83$ . In the study of Alex S.Ha (2021) the fixation segment was  $13.3 \pm 5$  [3] and in Smiths study, it was 82.6[4]. Thus, in order to correct spinal deformities due to degeneration, long fixation is required and combined with lumbar interbody fusion or/and osteotomy techniques. The mean postoperative hospital stay was  $11.2 \pm 9.2$  days.

After 6 months of surgery, most of our patients improved their leg pain and back pain according to the VAS score. The average VAS score in the back and legs after 6 months decreased to  $2.33 \pm 0.81$  and  $2.73 \pm 1.03$ , respectively. This decreased was statistically significant with  $p < 0.05$ . The average postoperavtive ODI (6 months) was decreased to 22.4% (pre operation was 44.4%),  $p < 0.05$ . The study of Alex S.Ha also gave similar results to ours result with the decreased of ODI from 38.6% to 18.7% post operation [3].



Figure 3. Full spine X ray: Pre operative and post operative measurements (Pts: Nguyen Thi H.) (pre -ope SVA: 50mm, post- ope SVA: 14mm; pre ope ODI: 30, post ope ODI: 17)

After surgery, the parameters on the vertical plane improved: The thoracic kyphosis angle increased to  $19.91 \pm 6.42^\circ$ , the mean SVA decreased to  $42.22\text{mm}$ , the postoperative LL was  $22.58^\circ$ . This improvement is statistically significant with  $p < 0.05$ . PI-LL mismatch reduced to  $22,0311,93^\circ$  the improvement of PI, PT is not statistically significant  $p > 0.05$ . In Matsumura's study, TK increased from  $15.5^\circ$  to  $25.9^\circ$ , LL from  $20^\circ$  to  $46^\circ$ , improved PI-LL obviously from  $31.5^\circ$  to  $4.3^\circ$ . [8] Our patient has just been well corrected in terms of SVA and TK, LL, while the lumbar deviation of PI LL has not improved. The authors' research shows that with PI-LL mismatch  $> 10^\circ$ , it affects the quality of life. [6]

The target of alignment correction should be individualized for each patient, most ASD patients have poor bone quality, so the correction be come much more difficult. In addition, degenerative changes in the discs, deformation of joints, narrowing of the spinal canal make the spine more rigid. For good correction, an osteomy can be performed such as the Smith-Peterson osteomy, but this procedures can only adjust  $5-15^\circ$  per segment and is only effective when the intervertebral disc is still flexible enough. Therefore, we performed transforaminal lumbar interbody fusion (TLIF). Researcher shows that TLIF increases lumbar lordosis by  $10^\circ$  and in the horizontal and  $6.8^\circ$  in each level of the sagittal planes. [8] In this study, we did not try to correct the deformities as much as possible, which was very

difficult because of a longer surgery time, a lot of blood loss, a long recovery time, etc. Patient's quality of life was improved significantly through the ODI scale and the SRS-22 questionnaire.

After 6 months, the quality of life according to the SRS-22 questionnaire improved with statistical significance: total SRS (preoperation:  $0.75 \pm 0.23$  increased to  $2.53 \pm 0.6$ , SRS function (preoperation:  $1.49 \pm 0.29$  increased to  $3.01 \pm 0.75$ ), SRS pain (preoperation:  $2.27 \pm 0.49$  increased to  $3.83 \pm 0.49$ ), SRS self image (preoperation:  $1.39 \pm 0.26$  increased to  $3.11 \pm 0.74$ ), SRS mental health (preoperation  $2.69 \pm 0.58$  increased to  $3.93 \pm 0.60$ ). Research results of Alex Ha (2021) also gave similar results with: SRS funtion (from  $2.9 \pm 0.9$  to  $3.9 \pm 1.0$ ), SRS pain (from  $2.8 \pm 0.9$  to  $3.9 \pm 1.0$ ). [3] A. Matsumura's study (2016) showed the results of total SRS (from  $2.87$  to  $4.00$ ), SRS funtion (from  $3.3$  to  $4.3$ ), SRS self image (from  $2.2$  to up  $4.0$ ), SRS mental health ( $3.6$  to  $4.2$ ). [8] The satisfaction level of patients after surgery was assessed according to the SRS-22 questionnaire, in our study, the satisfaction SRS was  $4.23 \pm 0.78$ , this result is similar to Matsumara's study was  $4.3$ . [8]

In our study, 2 patients had surgical site infection (SSI), accounting for  $13.3\%$ . This ratio in Smith's study was  $28\%$ . [4] There was 01 patient with superficial SSI who received suture removal, daily dressing change combined with intravenous antibiotic treatment for 2 weeks and oral antibiotics for the 2 weeks later. The infection cleared up after

1 month of treatment. Patients with deep SSI was treated by vacuum assisted closure (VAC) for 1 month, closed the incision, and he had been received antibiotics for 6 months. Currently the patient has been fine, the wound healing is well now.

There was one patient (6.7%) had complications of PJK after 6 months, this patient was fixed from T10 to S2, clinically, the patient had pain in the thoracic spine, X-ray showed kyphosis at T9-T10. This patient has severe deformity with negative lubar lordosis, a large preoperative thoracic kyphosis, high PI-LL mismatch, it was very difficult to got a correction. Some risk factors for proximal kyphosis (PJK) are trying to correct large deformity, old age, large SVA, high PI-LL mismatch. This complication according to Smith (2018) is classified as a major complication after surgery, the rate of this complication is 8/86 patients, accounting for 9.3%, of which 7 patients have to have revision surgery to fix it up.[4] There are some methods studied to prevent complications of PJK, such as reducing the stiffness of rod or increase the power at the highest segment, such as injecting cement into the proximal segment [9].

Complications of rod fracture, screw fracture, screw loose... were not found in our study, possibly because our sample size was not enough, the follow-up time was not long enough.

## Conclusions

S2 alar-iliac (S2AI) fixation for long fusions provides safe and effective correction in the saggital planes and improves life's quality postoperative. However, this is a major surgery, which needs to be coordinated by many specialties: radiologists, surgeons and anesthesiologists. A long-term follow-up period is required to assess the long outcome.

**Conflict of interest:** The authors declare that they have no conflict of interest.

## References

1. Wu AM, Chen D, Chen CH, et al. The technique of S2-alar-iliac screw fixation: a literature review. *AME Medical Journal*. 2017;2(12). Accessed January 31, 2021. <https://amj.amegroups.com/article/view/4197>
2. S1 Pedicle and delta screw. site name. Accessed October 25, 2021. <https://surgeryreference.aofoundation.org/spine/deformities/spondylolisthesis/basic-technique/s1-pedicle-and-delta-screw>
3. Ha AS, Hong DY, Luzzi AJ, et al. Minimum 2-Year Analysis of S2-Alar-Iliac Screw Fixation for Adult Spinal Deformity. *Global Spine Journal*. Published online January 7, 2021:2192568220984478. doi:10.1177/2192568220984478
4. Smith EJ, Kyhos J, Dolitsky R, Yu W, OBrien J. S2 Alar Iliac Fixation in Long Segment Constructs, a Two- to Five-Year Follow-up. *Spine Deform*. 2018;6(1):72-78. doi:10.1016/j.jspd.2017.05.004
5. Nguyen Vu (2016). "Study on treatment of lumbar spondylolisthesis by means of spinal fixation through the pedicle combined with intervertebral fusion welding". Thesis of Doctor of Medicine. Hanoi Medical University.
6. Ailon T, Smith JS, Shaffrey CI, et al. Degenerative Spinal Deformity. *Neurosurgery*. 2015;77 Suppl 4:S75-91. doi:10.1227/NEU.0000000000000938
7. Vo Van Thanh. (2014). Results of treatment of lumbar spondylolisthesis L4-L5 by discectomy, spinal fixation, intervertebral bone grafting. Graduation resident doctor thesis, Hanoi Medical University.
8. Matsumura A, Namikawa T, Kato M, et al. Posterior corrective surgery with a multilevel transforaminal lumbar interbody fusion and a rod rotation maneuver for patients with degenerative lumbar kyphoscoliosis. *J Neurosurg Spine*. 2017;26(2):150-157. doi:10.3171/2016.7.SPINE16172
9. Kebaish KM, Martin CT, OBrien JR, LaMotta IE, Voros GD, Belkoff SM. Use of vertebroplasty to prevent proximal junctional fractures in adult deformity surgery: a biomechanical cadaveric study. *Spine J*. 2013;13(12):1897-1903. doi:10.1016/j.spinee.2013.06.039