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The effect of anterior superior iliac spine preservation on donor site morbidity and function after harvesting a vascularized iliac bone flap

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Abstract

Background: The purpose of this study was to investigate the effect of anterior superior iliac spine (ASIS) preservation on donor site morbidity and function after harvesting a vascularized iliac bone flap (VIBF).

Methods: Patients who underwent jaws reconstruction with VIBF were divided into a maintaining the anterior superior iliac spine (MASIS) group and a not maintaining the anterior superior iliac spine (NMASIS) group. Pain, tenderness, sensory deficit, gait disturbance, and function of the donor site were evaluated before and after the operation.

Results: Thirty-three patients were included in this study, of which 18 were in the MASIS group. The incidence of sensory deficit in the MASIS group was significantly lower than that in the NMASIS group (50.0% vs. 86.7%, $p = 0.010$). Pain, tenderness, gait disturbance, and function did not differ statistically between the two groups.

Conclusion: Except for sensory deficit, ASIS preservation has minimal impact on donor site morbidity and function.

KEYWORDS

anterior superior iliac spine, donor site function, donor site morbidity, jaw reconstruction, vascularized iliac bone flap

1 | INTRODUCTION

Segment jaw defects caused by trauma, tumor resection, and inflammation usually require autologous bone grafts for reconstruction, thus allowing surgeons to achieve functional rehabilitation and esthetic reconstruction. At present, the most commonly used autologous bone transplantation method includes a free fibula flap and a vascularized iliac bone flap (VIBF).[1,2] The vascularized iliac bone flap not only has sufficient bone mass, but also has a similar curvature and thickness to the jawbone, thus providing better repair conditions for postoperative implant denture restoration; these advantages have led to this technique being commonly used in clinical practice.[3–6] However, as flap harvesting has direct effects on donor site morbidity and function, donor site morbidity, and the effect of surgery on donor site function after harvesting the VIBF, have gradually become significant concerns.[7–9]

To reduce the occurrence of donor site complications, Winters et al.[10] suggested maintaining the anterior superior iliac spine (ASIS) to preserve the anatomical structure in a

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more complete manner; however, this was associated with a risk of postoperative fracture in the anterior superior iliac spine. In another study, Brown[11] suggested the maintenance of at least 2 cm of the ASIS to preserve more anatomical tissue and reduce the occurrence of donor site complications.

To the best of our knowledge, no previous study has compared the incidence of donor site complications and functional change after harvesting vascularized iliac bone flap with and without preservation of the anterior superior iliac spine. Hence, the aim of this study was to set up a prospective clinical study to compare functional parameters and donor-site morbidities between patients who underwent surgery with and without maintenance of the anterior superior iliac spine.

2 | PATIENTS AND METHODS

2.1 | Design

This was a prospective clinical cohort study. The study was performed in accordance with the criteria established by the Helsinki Declaration and was approved by the Ethics Committee of Peking University School and Hospital of Stomatology (protocol no. PKUSSIRB-202171197).

2.2 | Patients

Patients who underwent head and neck tumor resection and reconstruction with a vascularized iliac bone flap were recruited from the Department of Oral and Maxillofacial Surgery, Peking University School and Hospital of Stomatology, from September 2020 to December 2021. The exclusion criteria were as follows: (1) age >65 years or <15 years; (2) patients with severe systemic disease; (3) patients with a history of severe trauma or neuropathy in the lower limb; and (4) surgeries not completed by the same surgeon. Written informed consent was obtained from all patients. Once the plan for reconstruction surgery had been decided, we collected a range of preoperative information at baseline and assigned patients into those who underwent maintenance of the anterior superior iliac spine (the MASIS Group) and those who did not undergo maintenance of the anterior superior iliac spine (the NMASIS Group).

2.3 | Surgical method

Vascularized iliac bone flap harvesting was conducted by one experienced surgeon following the method originally described by Taylor et al.[12] and Wolff et al[13] The primary difference between the two flaps was whether the ASIS was harvested with a vascularized iliac bone flap or not. In the MASIS group, we preserved at least 2 cm of the ASIS to maintain the attachment of sartorius muscle, tensor fasciae latae, and the inguinal ligament. In both groups, the vascularized iliac bone flaps carried 1 cm of internal oblique muscle to protect the pedicle. And the flap carried a small musculus obliquus externus abdominis to close soft tissue wounds and provide a monitor window. During the operation, according to the anterior superior iliac spine and the iliac crest, the pedicle artery and vein and the anterolateral femoral cutaneous nerve were identified and protected. After excision of the flap, we recorded a range of information relating to the flap (Figure 1).

2.4 | Outcome measurements

We collected a range of demographic characteristics for each patient as well as disease and treatment information, including age, sex, body mass index (BMI), tumor, flap donor site, distance between the posterior boundary of osteotomy and the ASIS, and the height and length of the iliac bone. Each patient was followed-up for 6 months after surgery. Donor site morbidity and function was recorded by the same clinician. Outcome measurements were divided into subjective and objective assessments. The evaluation time points were pre-operation (T0), 3 months (T1), and 6 months (T2) post-surgery.

2.4.1 | Subjective evaluation

Subjective evaluation included pain, tenderness, sensory deficit, gait disturbance and satisfaction. The degree of pain and tenderness at the donor site was assessed by the Visual Analogue Scale (VAS) which ranged from 0 to 10, with 0 indicating no pain and 10 indicating the most severe pain imaginable; the VAS was scored by the patients according to their actual experience. The sensory deficit examination recorded whether the patient experienced paresthesia, such as numbness in the lateral thigh region, and whether the symptoms improved or not. Satisfaction was assessed on a scale of 10, with 0 being very dissatisfied and 10 being very satisfied. Patients were asked to walk forwards and backwards in a straight line on a smooth floor for 40 meters to test for gait disturbance; then, we ranked the walking from 0 (no abnormality) to 3 (considerable gait abnormality), with 0 representing no

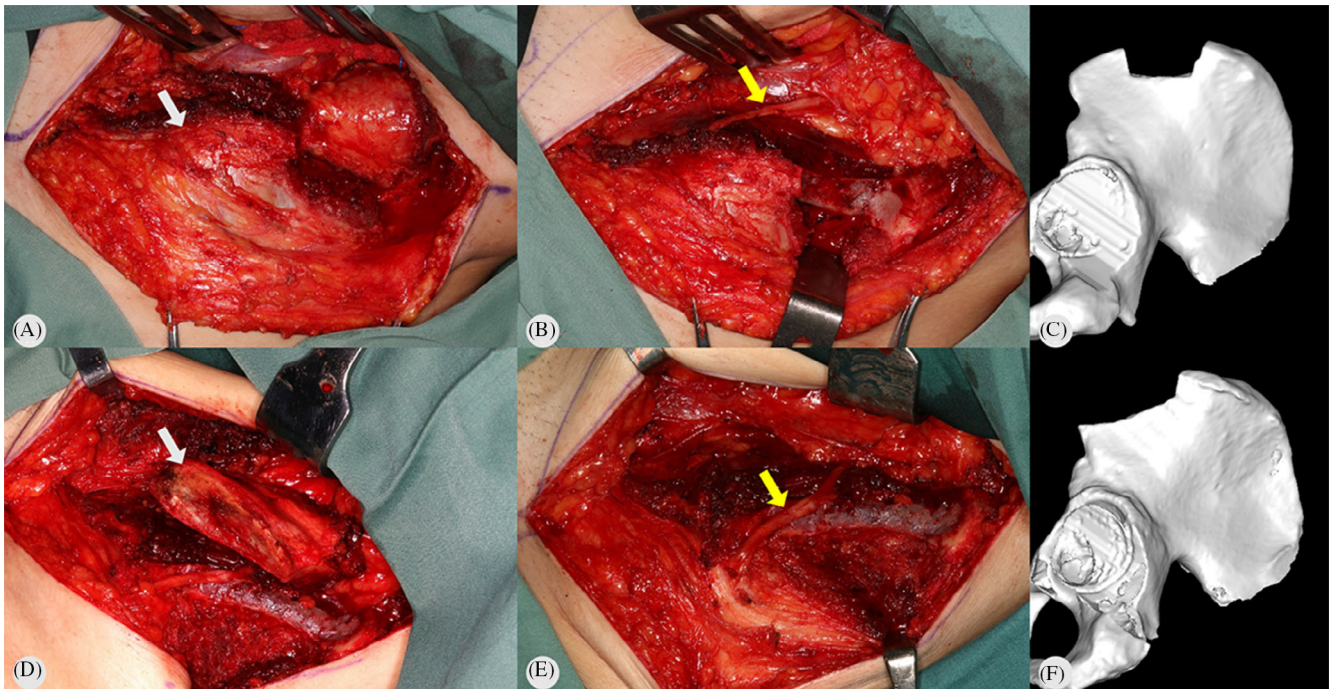

FIGURE 1 Intraoperative pictures and postoperative three-dimensional (3D) reconstruction of ilium pictures of the two surgical methods. (A) Dissecting the vascularized iliac bone flap without ASIS; (B) finishing harvesting the vascularized iliac bone flap without ASIS; (C) 3D reconstruction of the ilium in MASIS group postoperatively; (D) dissecting the vascularized iliac bone flap with ASIS; (E) finishing harvesting the vascularized iliac bone flap with ASIS; (F) 3D reconstruction of the ilium in NMASIS group postoperatively. The white arrows in (A) and (D) show the anterior superior iliac spine, and the yellow arrows in (B) and (E) show the pathway of anterolateral femoral cutaneous nerve intra-operation. [Color figure can be viewed at wileyonlinelibrary.com]

abnormality (normal, preoperative), one representing minimal abnormality with mild signs of limping, two representing apparent abnormality such as limping without the need for assistance, and three represented considerable gait abnormality and the need to use assistive devices to ambulate. Patients were also asked if they had any other complaints.

2.4.2 | Objective evaluation

The objective evaluation involved fracture, hernia, the Harris Hip Score (HHS), and range of motions. Physical examinations were conducted to evaluate hernia and fracture.

The HHS was developed to assess the outcomes of hip surgery[14,15] and features 10 items for assessment with a total score of between 0 and 100. A value of 90 and higher represents an excellent outcome while a value of 70 or less is considered a poor outcome. Range of motion in the hip joint was tested in various ways, including flexion, posterior extension, adduction, abduction, internal rotation, and external rotation. Each measurement was repeated three times and averaged. Figure 2 shows a flowchart of the workflow.

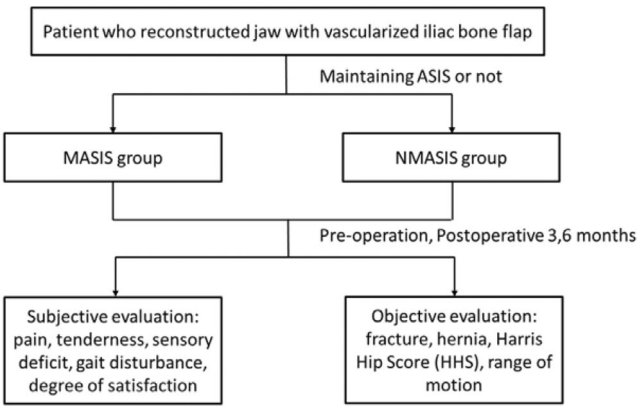

FIGURE 2 Evaluation flow chart.

2.5 | Statistical methods

Statistical analyses were conducted using SPSS version 26.0 software. Continuous variables that were normally distributed are described by mean and SD and were analyzed by the two independent samples t-test. However, variables that were not normally distributed are described by median and interquartile range (IQR) and were analyzed by the Mann–Whitney *U* test. Categorical

TABLE 1 Clinical features of patients in two groups.

Variable	Category	Mean score ± SD or *n* (%)				
		Total patients ($n = 33$)	MASIS group ($n = 18$)	NMASIS group ($n = 15$)	*t*	*p*
Age (years)[a]		36.5 ± 11.9	36.2 ± 9.7	36.9 ± 14.5	−0.168	0.868
Sex[b]					–	0.085
	Male	15 (44.1)	5 (27.8)	9 (60.0)		
	Female	19 (55.9)	13 (72.2)	6 (40.0)		
BMI[a]		25.0 ± 4.5	23.8 ± 3.5	26.0 ± 5.1	−1.831	0.077
Comorbidity[b]					–	0.665
	Yes	6 (18.2)	4 (22.2)	2 (13.3)		
	No	27 (81.8)	14 (77.8)	13 (86.7)		
Tumor[b]					–	0.283
	Malignant	10 (30.3)	7 (38.9)	3 (20.0)		
	Benign	23 (69.7)	11 (61.1)	12 (80.0)		
Donor site[b]					–	1.000
	Left	14 (42.4)	8 (44.4)	6 (40.0)		
	Right	19 (57.6)	10 (55.6)	9 (60.0)		
Distance between the A and P (cm)[a]		6.7 ± 1.5	6.4 ± 1.3	7.2 ± 1.7	1.468	0.152
Hight of the iliac bone (cm)[a]		2.8 ± 0.4	2.7 ± 0.3	2.9 ± 0.4	1.902	0.067
Length of the iliac bone (cm)[a]		5.8 ± 1.9	4.6 ± 1.2	7.2 ± 1.7	5.015	0.000*

Note: Distance between the A and P: Distance between the anterior superior iliac spine and posterior boundary of osteotomy; *$p < 0.05$.
[a]Two independent sample *t*-test.
[b]Fisher's exact test.

variables are reported as frequencies and percentages and were analyzed by Fisher's exact test. Rank data were analyzed by the Wilcoxon Rank Sum test. Generalized estimating equations (GEE) were used to evaluate the influence upon range of motion in the two groups and one-way analysis of variance (ANOVA), along with the post-hoc Tukey HSD (Honestly Significant Difference) Test Calculator was used to compare the range of motion over multiple time points. All tests were two-sided and $p < 0.05$ were considered statistically significant.

3 | RESULTS

3.1 | Patient characteristics

A cohort of 33 patients was enrolled during the study period. The MASIS group consisted of 18 patients, while the NMASIS group consisted of 15 patients. Except for three patients in the NMASIS group who could not return to the hospital for review in T2, all of the patients completed the entire study. Last observation carried forward analysis (LOCF) was used to complete the missing data for the three patients. There were no significant differences between the two groups in terms of sex, age, BMI, comorbidities, tumor, flap donor site, distance between the posterior boundary of osteotomy and the ASIS, or height of the iliac bone; however, there was a significant difference in the length of the iliac bone between the two groups ($p < 0.05$; see Table 1).

3.2 | Donor site morbidities

The median of pain VAS score was 1 and 0 in both groups when determined at three and 6 months after surgery ($p > 0.05$), while the median tenderness VAS score was 1.0 in the MASIS group and 0 in the NMASIS group ($p > 0.05$). All patients in the NMASIS group experienced

TABLE 2 Comparison of donor site morbidities between two groups at each time point.

	Median (p25 ~ p75) or *n* (%)							
	3 months				6 months			
Morbidity	MASIS group ($n = 18$)	NMASIS group ($n = 15$)	z	p	MASIS group ($n = 18$)	NMASIS group ($n = 15$)	z	p
Pain[a]	1.0 (0 ~ 2.0)**	1.0 (0 ~ 2.0)***	−0.973	0.331	0 (0 ~ 2.5)	0 (0 ~ 0)	−0.701	0.483
Tenderness[a]	2.0 (0 ~ 2.3)**	1.0 (0 ~ 2.0)***	−0.886	0.376	1.0 (0 ~ 2.0)	0 (0 ~ 1.0)	−1.513	0.130
Sensory deficit[b]	11 (61.1)	15 (100.0)	–	0.009*	9 (50.0)	13 (86.7)	–	0.010*
Hernia[b]	0	0	–	–	0	1 (6.7)	–	0.455
Gait disturbance[bc]			−1.344	0.179			−0.812	0.417
0	14 (77.8)	9 (60.0)			16 (88.9)	12 (80.0)		
1	4 (22.2)	3 (20.0)			2 (11.1)	1 (6.7)		
2	0	3 (20.0)			0	2 (13.3)		
3	0	0			0	0		

Note: *$p < 0.05$ between the two groups; **$p < 0.05$ between 3 and 6 months in MASIS group; ***$p < 0.05$ between 3 and 6 months in NMASIS group.
[a]Mann–Whitney *U* test.
[b]Fisher's exact test.
[c]Wilcoxon Rank Sum Test.

sensory deficit; this compared with 61.3% of patients in the MASIS group when determined 3 months after surgery ($p < 0.05$). The percentage of sensory deficit 6 months after surgery in the MASIS group was 50.0% while that in the NMASIS group was 86.7% ($p < 0.05$).

The percentage of apparent abnormality, such as limping without the need of assistance, in the NMASIS group was 20% and 13.3% when determined three and 6 months after surgery, respectively; this compared with 0% in the MASIS group. There was no significant difference between the two groups in this respect. One out of 15 patients (6.7%) developed a hernia in the NMASIS group; none of the patients in the MASIS group developed this condition ($p > 0.05$; see Table 2).

3.3 | Donor site function and satisfaction

3.3.1 | Range of motion

GEE analysis revealed no significant differences in the range of motion by group and interaction effects of group and time ($p > 0.05$). However, there was a statistically significant difference by time ($p < 0.05$; Table 3). Although there were no significant differences in range of motion between the two groups at each time point, we found that abduction and adduction in the NMASIS group were significantly different when compared between pre-operation and 3 months. Furthermore, adduction in the MASIS group was significantly different when compared between pre-operation and 3 months ($p < 0.05$). In both groups, the range of motion did not differ significantly when compared between pre-operation and 6 months (Figure 3). Except for the reduction of flexion at 6 months, there were significant differences between the two groups in terms of reduction in the range of motion, the reduction of flexion, posterior extension, and abduction in the MASIS group, and the reduction of flexion, posterior extension, abduction and external rotation in the NMASIS group when compared between 3 months and 6 months ($p < 0.05$; Table 4).

3.3.2 | Harris hip score and satisfaction

Although there was no significant difference in the HHS score and satisfaction score between the two groups, there were significant differences in pain, function and total HHS score when compared between 3 months and 6 months in both groups ($p < 0.05$; Table 5). The median HHS in both groups was 100.0 and the median satisfaction was 8.0 in both groups at 6 months postoperatively.

4 | DISCUSSION

Since Urken et al.[16] first reported the use of a vascularized iliac bone flap to reconstruct the jaw in 1989, this

TABLE 3 GEE analysis of range of motion in two groups.

	Items	Values	β	SE	Wald x^2	p valve
Flexion	(Intercept)		119.693	1.701	4951.026	0.000*
	Group	MASIS	−0.460	2.227	0.043	0.836
		NMASIS	0[a]	–	–	–
	Time point	6 months	−2.547	0.677	14.154	0.000*
		3 months	−4.260	0.895	22.650	0.000*
		Pre-operation	0[a]	–	–	–
	Group × time point	MASIS × 6 months	1.113	1.136	0.961	0.327
		MASIS × 3 months	1.182	1.474	0.643	0.423
		MASIS × Pre-operation	0[a]	–	–	–
Posterior extension	(Intercept)		21.953	1.676	171.553	0.000*
	Group	MASIS	−0.042	2.115	0.000	0.984
		NMASIS	0[a]	–	–	–
	Time point	6 months	−1.713	0.775	4.882	0.027*
		3 months	−2.567	0.910	7.964	0.005*
		Pre-operation	0[a]	–	–	–
	Group × time point	MASIS × 6 months	0.758	0.866	0.766	0.381
		MASIS × 3 months	0.311	1.079	0.083	0.773
		MASIS × Pre-operation	0[a]	–	–	–
Adduction	(Intercept)		27.353	1.341	415.857	0.000*
	Group	MASIS	4.258	2.556	2.776	0.096
		NMASIS	0[a]	–	–	–
	Time point	6 months	−2.667	0.991	7.235	0.007*
		3 months	−4.080	1.021	15.974	0.000*
		Pre-operation	0[a]	–	–	–
	Group × time point	MASIS × 6 months	−0.311	1.864	0.028	0.867
		MASIS × 3 months	−1.414	2.067	0.468	0.494
		MASIS × Pre-operation	0[a]	–	–	–
Abduction	(Intercept)		61.560	2.240	755.605	0.000*
	Group	MASIS	−0.271	3.015	0.008	0.928
		NMASIS	0[a]	–	–	–
	Time point	6 months	−4.893	1.634	8.967	0.003*
		3 months	−11.727	2.642	19.704	0.000*
		Pre-operation	0[a]	–	–	–
	Group × time point	MASIS × 6 months	2.038	1.777	1.316	0.251
		MASIS × 3 months	0.177	3.227	0.003	0.956
		MASIS × Pre-operation	0[a]	–	–	–
Internal rotation	(Intercept)		25.593	1.196	458.056	0.000*
	Group	MASIS	0.084	1.836	0.002	0.963
		NMASIS	0[a]	–	–	–
	Time point	6 months	−1.907	0.741	6.617	0.010*
		3 months	−2.267	0.803	7.966	0.005*
		Pre-operation	0[a]	–	–	–
	Group × time point	MASIS × 6 months	1.257	0.847	2.204	0.138

(Continues)

TABLE 3 (Continued)

	Items	Values	β	SE	Wald x^2	p valve
		MASIS × 3 months	1.344	0.921	2.133	0.144
		MASIS × Pre-operation	0[a]	–	–	–
External rotation	(Intercept)		19.773	0.779	644.814	0.000*
	Group	MASIS	0.432	1.401	0.095	0.758
		NMASIS	0[a]	–	–	–
	Time point	6 months	−0.847	0.379	5.003	0.025*
		3 months	−2.527	0.721	12.287	0.000*
		Pre-operation	0[a]	–	–	–
	Group × time point	MASIS × 6 months	0.041	0.495	0.007	0.934
		MASIS × 3 months	1.043	0.952	1.201	0.273
		MASIS × Pre-operation	0[a]	–	–	–

Note: [a] and – indicate the reference group, *$p < 0.05$.
Abbreviation: GEE, generalized estimating equations.

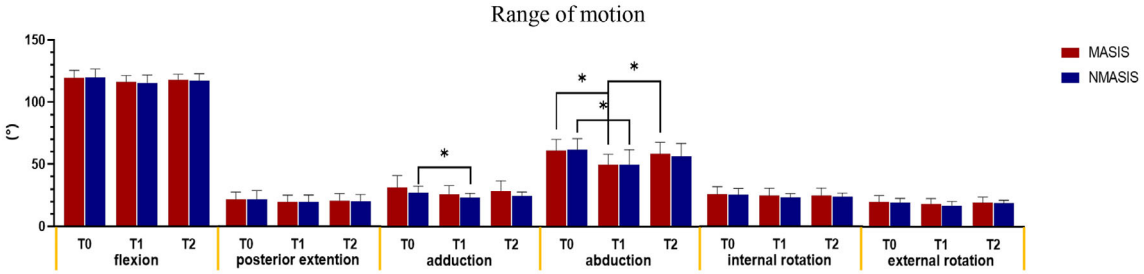

FIGURE 3 Comparison of range of motion in two groups at each time point. T0: preoperation; T1: 3 months postoperation; T2: 6 months postoperation; *$p < 0.05$. [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 4 Comparison of range of motion reduction between two groups at each time point.

	Median (p25 ~ p75)							
	3 months				6 months			
	MASIS ($n = 18$)	NMASIS ($n = 15$)	Z	p	MASIS ($n = 18$)	NMASIS ($n = 15$)	Z	p
Flexion (°)	0.9 (0.3 ~ 3.2)[a]	2.7 (1.5 ~ 6.5)[b]	−1.666	0.096	0.2 (−0.4 ~ 1.0)	1.7 (1.0 ~ 3.3)	−2.787	0.005*
Posterior extension (°)	2.2 (−0.4 ~ 1.0)[a]	0.5 (0.0 ~ 5.3)[b]	−0.217	0.828	0.2 (−0.2 ~ 1.9)	0.3 (−0.2 ~ 2.8)	−0.345	0.730
Adduction (°)	2.5 (−0.1 ~ 10.7)	2.3 (0.7 ~ 7.5)	−0.434	0.664	0.9 (−0.1 ~ 5.1)	1.3 (0.5 ~ 6.3)	−0.543	0.587
Abduction (°)	12.7 (2.0 ~ 18.3)[a]	7.3 (2.0 ~ 22.7)[b]	−0.054	0.957	2.2 (0.5 ~ 4.0)	2.0 (0.8 ~ 7.3)	−0.579	0.563
Internal rotation (°)	0.0 (−0.3 ~ 1.3)	0.5 (0.0 ~ 4.0)	−1.672	0.095	0.0 (−0.2 ~ 0.9)	0.4 (0.0 ~ 3.5)	−1.309	0.190
External rotation (°)	0.4 (−0.8 ~ 2.4)	1.2 (0.2 ~ 3.7)[b]	−1.286	0.199	0.3 (−0.2 ~ 1.4)	0.2 (0.0 ~ 1.5)	−0.073	0.942

Note: *$p < 0.05$ between the two groups; [a]$p < 0.05$ between 3 and 6 months in MASIS group; [b]$p < 0.05$ between 3 and 6 months in NMASIS group.

technique has been increasingly applied in maxillofacial surgery due to the provision of an adequate bone volume and the shape of the iliac bone to match the jaw.[1] However, the problem of donor site complications has been a persistent problem for patients. Previous studies described a range of donor site complications, including pain, tenderness, gait disturbances, sensory deficit, as well as hernia and fracture.[7–9,17,18] Therefore, it is essential to reduce the incidence of donor site complications. Although some studies have suggested that the anterior superior iliac spine should be preserved when harvesting iliac bone flaps to reduce the incidence of donor site

TABLE 5 Comparison of HHS and satisfaction between two groups at each time point.

	Median (p25 ~ p75)							
	3 months				6 months			
	MASIS group ($n = 18$)	NMASIS group ($n = 15$)	*Z*	*p*	MASIS group ($n = 18$)	NMASIS group ($n = 15$)	*Z*	*p*
HHS								
Pain	40.0 (40.0 ~ 44.0)[a]	40.0 (40.0 ~ 44.0)[b]	−0.070	0.944	44.0 (44.0 ~ 44.0)	44.0 (40.0 ~ 44.0)	−1.095	0.273
Function	46.0 (43.0 ~ 46.0)[a]	46.0 (43.0 ~ 46.0)[b]	−0.590	0.555	46.0 (46.0 ~ 46.0)	46.0 (46.0 ~ 46.0)	−0.262	0.793
Absence of deformity	4.0 (4.0 ~ 4.0)	4.0 (4.0 ~ 4.0)	0.000	1.000	4.0 (4.0 ~ 4.0)	4.0 (4.0 ~ 4.0)	0.000	1.000
Range of motion	5.0 (5.0 ~ 5.0)	5.0 (5.0 ~ 5.0)	0.000	1.000	5.0 (5.0 ~ 5.0)	5.0 (5.0 ~ 5.0)	0.000	1.000
Total score	96.0 (93.0 ~ 97.0)[a]	96.0 (93.0 ~ 97.0)[b]	−0.188	0.851	100.0 (97.0 ~ 100.0)	100.0 (96.0 ~ 100.0)	−1.075	0.283
Satisfaction	8.0 (6.0 ~ 9.0)	8.0 (7.0 ~ 8.0)	−0.056	0.955	8.0 (7.0 ~ 10.0)	8.0 (8.0 ~ 9.0)	−0.508	0.611

Note: $^*p < 0.05$ between the two groups; $^a p < 0.05$ between 3 months and 6 months in MASIS group; $^b p < 0.05$ between 3 months and 6 months in NMASIS group.

complications,[10,11] there is a lack of evidence to support this opinion. Therefore, in this study, we aimed to follow-up this type of patients to provide reference guidelines for clinical decision making when reconstructing jaws with an iliac bone flap.

Pain is one of the major donor site complications after iliac bone harvesting.[9,19,20] In this study, we found that preserving the anterior superior iliac spine (or not) had less influence on the severity of pain and tenderness; these findings are consistent with those of Valentini et al[18] The degree of pain and tenderness were slight in both groups at three and 6 months postoperatively; these findings are similar to those reported by Ling et al.[21] and Shin et al[22] Furthermore, there was a clear trend for pain and tenderness to be relieved postoperatively.

We also found that preservation of the anterior superior iliac spine could significantly reduce the incidence of anterolateral femoral cutaneous nerve abnormalities following iliac flap preparation. Previous anatomical studies have found that the anterolateral femoral cutaneous nerve travels beneath the inguinal ligament to a point that is 1.3 to 5.1 cm medial to the anterior superior iliac spine.[23,24] According to the relationship between the anterolateral femoral cutaneous nerve and ASIS, Mischkowski et al.[25] found that the anterolateral femoral cutaneous nerve's course can be divided into two major categories: superolateral to ASIS and inferomedial to ASIS in a human cadaver study, and there were 2.9% of the anterolateral femoral cutaneous nerve crossing superolateral to the ASIS. Therefore, preserving the anterior superior iliac spine may avoid stripping of the anterior lateral femoral cutaneous nerve, thereby reducing the risk of injury. At 3 months postoperatively, the incidence of sensory abnormalities was as high as 100% in the NMASIS group and 61.1% in the MASIS group. Due to the intraoperative protection of this nerve, at 6 months postoperatively, all patients in both groups reported a reducing degree of sensory abnormalities in the anterior lateral femoral region and a reduction in the extent of sensory abnormalities. Two patients in both groups returned to a normal state, with the rate of sensory abnormalities decreasing to 50% and 86.7%, respectively. Therefore, to reduce the occurrence of sensory abnormalities, it is necessary to protect the anterolateral femoral cutaneous nerve as much as possible when preparing the iliac flap whether the ASIS is preserved or not.

Gait disturbance is also a complication of iliac bone flaps.[26,27] In this study, the NMASIS group seems more likely to have apparent gait abnormality than the MASIS group, as limping without the need for assistance 6 months postoperatively was 13.3%, while none of the patients in the MASIS group had apparent gait disturbance. However, we found no statistically significant

difference in the degree and the incidence of gait disturbance when compared between the two groups. In a previous study, Cansiz et al.[28] used a gait analysis instrument to analyze gait after free iliac bone extraction and found that patients were able to recover their gait completely 3 weeks after surgery. This differs from our current findings, mainly because the vascularized iliac bone flap involved a greater extent of muscle stripping, thus causing more impact on gait. And maintaining the ASIS, we can preserve the attachment of the sartorius muscle, tensor fasciae latae, and the inguinal ligament, thus reducing the impact of surgery on gait.

Hernia is a serious donor site complication following iliac flap surgery. Although the wound was carefully and tightly sutured intraoperatively layer by layer in both groups, there was one patient in the NMASIS group with a confirmed hernia 6 months after surgery. The incidence of hernia in the NMASIS group was 1/15 (6.7%); this was similar to the 2%–9% incidence of hernia reported in previous studies.[29–31] However, there was no significant difference between the two groups in this study so we cannot yet assume that preserving the anterior superior iliac spine is effective in reducing the incidence of hernia. We reviewed the information of this patient and found that the patient had a BMI of 35.5, thus indicating that he was obese. Obesity has generally been considered a risk factor for incisional hernias in previous studies.[32,33] Therefore, more attention should be paid when an obese patient undergoes jaw reconstruction surgery with a vascularized iliac bone flap, whether the ASIS preserved or not.

In this study, two methods were used to assess donor site function: range of motion in the hip and HHS. The HHS was above 90 in both groups, and there was no statistical difference in pain, function, absence of deformity, and range of motion, when compared between the two groups for each item. Furthermore, the HHS had largely returned to preoperative levels by 6 months postoperatively; this finding was similar to that reported by previous studies.[21,34] Our research found that harvesting the vascularized iliac bone flap mainly affected adduction and abduction after surgery in the NMASIS group but had a greater effect on abduction in the MASIS group. According to anatomical structure, preserving the ASIS can maintain the attachment of the sartorius muscle and tensor fasciae latae, thus reducing the impact of abduction after surgery. However, the gluteus medius is the primary abductor; when harvesting a vascularized iliac bone flap, there is a need to dissect part of the gluteus medius; this is the main factor resulting in a decline of abduction. Our research found that hip mobility recovered over time and was similar to the preoperative level at 6 months; this was the case whether the ASIS was preserved or not (Table 4). In addition, GEE analysis of range of motion in the hip showed that postoperative hip mobility was not related to the preservation of the anterior superior iliac spine, but rather to postoperative time.

There are some limitations to this study that should be acknowledged. First, as the distance between the anterior superior iliac spine and posterior boundary of osteotomy in the two groups were not significantly different, and the MASIS group preserved at least 2 cm of the ASIS to prolong the length of the vascular pedicle, it can be expected that the length of iliac bone between the two groups were significantly different (Table 1). In a previous study, a vascularized iliac bone flap <9 cm in length can be regarded as in the same category, and the length of the iliac bone flap has less effect on donor site morbidity.[35] It is reasonable to consider that the two groups are therefore comparable. Second, as this study was a single-center study, the sample size was relatively insufficient; this may be a key limitation. Therefore, to obtain more precise data in the future, it is still necessary to expand the sample size.

5 | CONCLUSION

Except for sensory deficit, whether or not the ASIS is maintained when harvesting a vascularized iliac bone flap has no significant difference in terms of donor site morbidity. Donor site function can be restored to the preoperative normal level regardless of whether the ASIS was preserved or not. Thus, it is suggested that surgeons can choose between the two techniques when clinically needed.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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