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Iliac Periosteal Bone Autografting vs Talus Non-Weight-Bearing Surgery in Hepple V Talus Osteochondral Injuries: Comparative Analysis of Perioperative Outcomes

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Data Interpretation D
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Background: Hepple stage V osteochondral injuries of the talus include subchondral cyst formation, secondary degenerative change, and secondary osteoarthritis. This retrospective study aimed to compare perioperative outcomes from iliac periosteal bone autografting and talus non-weight-bearing surgery in 162 patients with Hepple V osteochondral injuries of the talus.

Material/Methods: According to the inclusion criteria, 162 eligible patients were selected for analysis and divided into an iliac periosteal bone autograft group (n=82) and a talus non-weight-bearing group (n=80) according to the surgical methods. General data and data on perioperative conditions, complications, intraoperative fluoroscopy times, preoperative and postoperative visual analog scale (VAS) for pain, ankle-hindfoot scoring system (AOFAS Ankle-Hindfoot Scale), and plantar flexion and extension range of motion were collected to assess ankle joint function and were compared between groups.

Results: The comparison of perioperative results between the 2 groups showed that the incision length (P=0.000), operation time (P=0.000), and length of hospital stay (P=0.000) in the iliac periosteal bone autograft group were longer than those in the talus non-weight-bearing group. The intraoperative blood loss in the anterior group was greater than that in non-weight-bearing group (P=0.000). Regarding complications, there were more cases of donor site paresthesia (P=0.014) and postoperative pain aggravation in the iliac periosteal bone autograft group than in the non-weight-bearing group.

Conclusions: In patients with Hepple V osteochondral injury of the talus, the incision length, operation time, and length of hospital stay in the talus non-weight-bearing group were shorter, there was less intraoperative blood loss, and there were fewer postoperative complications. In the short term, bone transplantation in the talus non-weight-bearing group was more "minimally invasive" and the postoperative recovery was better than in the iliac periosteal bone allograft group.

Keywords: **Ilium • Talus**

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Introduction

Osteochondral injury of the talus (OLT) is one of the most common sports injuries of the ankle joint [1], sometimes leading to joint instability and causing focal damage to the talar fornix cartilage and subchondral bone [2]. It accounts for approximately 4% of osteochondral injuries throughout the body, but the actual incidence may be higher [3]. It is characterized by pain around the ankle joint, which usually affects ankle joint movement at a later stage and even leads to gradual loss of joint function, seriously affecting quality of life [4]. At present, the mechanism of osteochondral injury of the talus is not clear. Steele et al [5] concluded that 98% of medial talar roof and 70% of lateral talar roof injuries were related to trauma, and medial cartilage injuries were not closely related to traumatic factors. Clinically, the classification used for osteochondral injuries of the talus is still based on the modified Hepple classification in MRI images [6]. While stage V is often refractory to conservative treatment, surgical treatment includes microfractures, iliac periosteal bone autograft, autologous bone or allogeneic osteochondral block transplantation, autologous chondrocyte transplantation, and autologous periosteal bone transplantation [7]. Hepple V stage is cartilage injury combined with subchondral bone cyst. At present, medial malleolus osteotomy and autologous bone grafting are usually used for Hepple stage V patients. Among them, the currently recognized surgical methods are iliac periosteal bone autograft and talus non-weight-bearing [8-10]. Among the causes of soft tissue injury, surgical methods are one of the influencing factors, and different surgical methods have become the focus of recent attention. Choosing the best surgical approach can significantly reduce the severity of pain and shorten the operation and anesthesia time, thereby increasing patient satisfaction with the operation. Few studies have analyzed the postoperative outcomes of the 2 surgical methods. Therefore, this retrospective study aimed to compare perioperative outcomes from iliac periosteal bone autografting versus talus non-weight-bearing surgery in 162 patients with Hepple V osteochondral injuries of the talus.

Material and Methods

Participants and Surgical Methods

Ethics Statement

The study was approved by the Ethics Committee of our hospital (12021-KY-010) and the requirement for informed consent was waived by the Ethics Committee of our hospital since this was a retrospective study and the data were anonymous.

Inclusion and Exclusion Criteria

The inclusion criteria were: age under 80 years; diagnosed with Hepple V talus osteochondral injury and initially treated with medial malleolus osteotomy, lesion debridement, and autologous bone grafting; follow-up time more than 1 year; surgeries were performed by the same senior surgeon experienced in surgery; complete clinical data; and imaging such as X-ray/CT/MRI showed subchondral bone cysts (>8 mm in diameter) (**Figure 1**).

The exclusion criteria were: ankle osteoarthritis or extensive cartilage degeneration of the talus; bone and joint infections; previous ankle surgery; incomplete medical records or radiological images; surgical contraindications and cannot tolerate surgery; refusal to sign informed consent or inability to complete treatment and follow-up.

Participants

This study retrospectively analyzed 162 patients who underwent medial malleolus osteotomy, lesion debridement, and

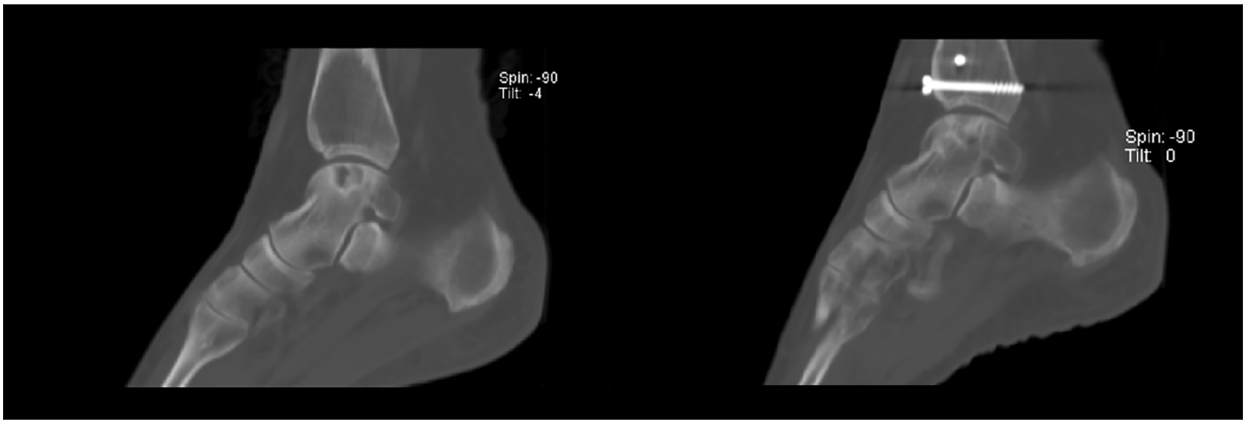

Figure 1. Preoperative and postoperative CT showed wear of the cartilaginous surface of the talus and bone cysts before surgery, and the articular surface of the talar fornix was flat 1 year after surgery, and cystic degeneration had basically filled and healed.

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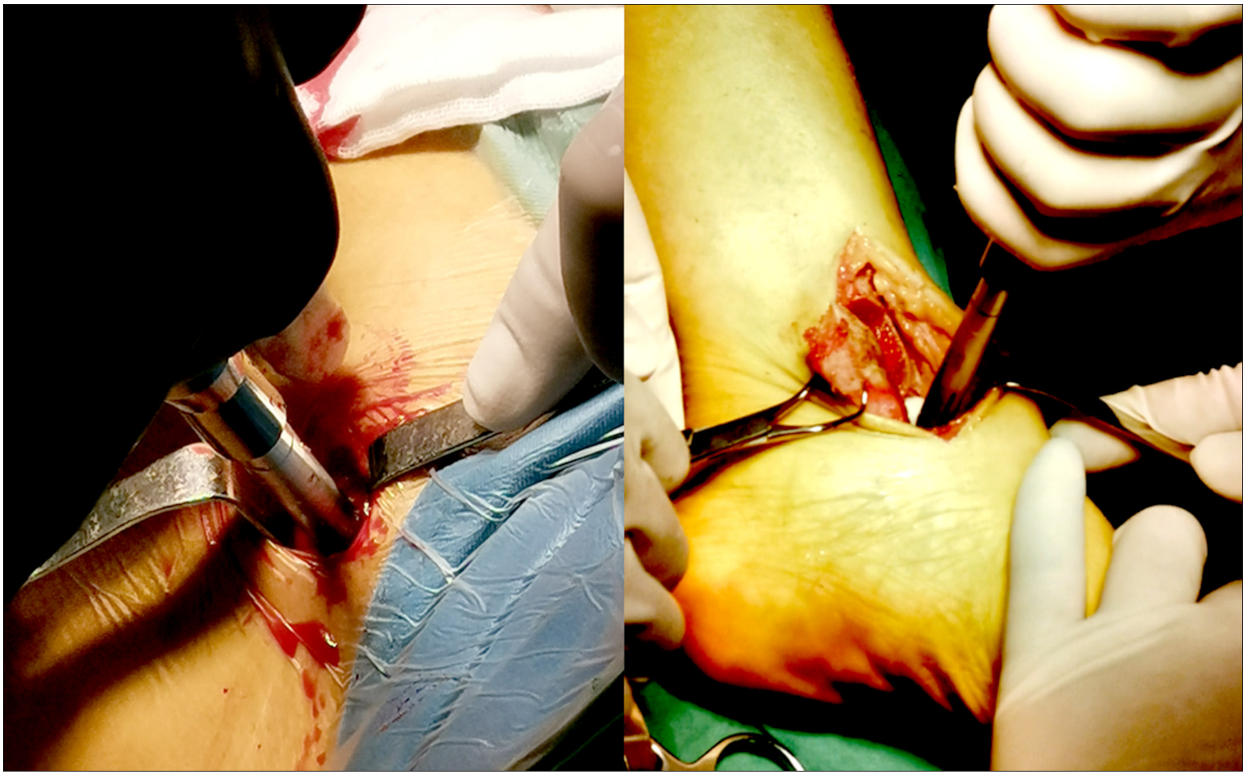

Figure 2. During the operation, the iliac bone and non-weight-bearing bone of the talus were taken.

autologous bone transplantation for Hepple stage V talar osteochondral injury in our hospital from January 2018 to December 2023, and were divided into an iliac periosteal bone autograft group (n=82) and a talus non-weight-bearing group (n=80) according to the surgical methods.

Surgical Methods

All procedures were performed by the same experienced chief surgeon, and preoperative templating was not routinely performed in any patient (**Figure 2**).

In patients in the iliac periosteal bone autograft group, a sterile pneumatic tourniquet was applied on the proximal thigh of the affected limb, followed by exsanguination and tourniquet inflation. The anteromedial arcuate incision of the affected ankle was about 6 cm in length, the soft tissue was separated layer-by-layer, and the medial malleolus was subjected to triplane osteotomy with an oscillating saw to expose the lesion area of the medial talar fornix, scratch and strip the cartilage, clean the necrotic cartilage, assess the size of the lesion, select the appropriate diameter extractor to punch the vertical articular surface, remove the lesion tissue and cyst, drill the microfracture of the sclerotic bone Kirschner wire around the cyst cavity, expose the ipsilateral anterior superior iliac crest, preserve the periosteum, and remove the periosteal bone plug from the vertical bone surface of the periosteum extractor. The diameter of the bone plug was equal to the diameter of the talar notch, and the length was slightly shorter than the notch. A small amount of cancellous bone particles was implanted at the bottom of the talus notch, the bone plug was compressed and impacted, and the cortical bone of the bone plug was flush with the subchondral bone of the talus. At this time, the periosteum on the bone plug was flush with the cartilaginous surface of the talus, the medial malleolus osteotomy block was reduced after the articular surface was matched in the active ankle joint, 3-4 headless hollow bone screws were screwed for compression fixation, and the incision was sutured layer-by-layer. Anterior talofibular ligament repair was also performed in patients with a preoperative diagnosis of anterior talofibular ligament injury combined with ankle instability.

In the talus non-weight-bearing group, the bone graft donor site was non-weight-bearing talus bone (bone extractor vertical talus non-weight-bearing bone cortex removal with cartilage bone plug, bone plug diameter and length equal to talus gap diameter and length). The remaining surgical methods were the same as in the iliac bone group.

Postoperative Management

Antibiotics were routinely used in both groups after surgery. Low-molecular-weight heparin sodium was administered 24

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hours after surgery until oral rivaroxaban was administered after discharge until 2 weeks after surgery. Postoperative rehabilitation instructions were given by dedicated nurses and rehabilitators. Following the principle of early mobilization and late weight-bearing, passive flexion and extension ankle exercises were started in the second week after surgery. Partial weight-bearing walking was started at 6 weeks after surgery and full weight-bearing walking started at 10 weeks after surgery. Six months after surgery, patients returned to normal life and low-intensity sports activities. Patients who underwent anterior talofibular ligament repair had the affected area immobilized in a plaster cast for 1 month after surgery, gradually performed functional exercise with ankle protection after 1 month, and full weight-bearing walking at the 10th week after surgery.

Outcome Measures

The basic data of all subjects were collected. The operation time, intraoperative blood loss, incision length, hospital stay, and intraoperative fluoroscopy times were recorded. All patients were followed up clinically and radiologically before surgery, at 3 months and 12 months after surgery, and at the last follow-up. At each follow-up visit, patients underwent VAS scoring, ankle-hindfoot scoring (AOFAS), and ankle range of motion to assess postoperative ankle function.

Statistical Analysis

PASS 15.0 software was used to calculate the sample size for the 2-sample *t* test, referring to the medium effect size of 0.52 recommended by Cohen (1988) [11], with a target statistical power of 0.90 and a significance level set at 0.05. The calculation showed that 79 samples per group were required to reach the study objective, for a total sample size of 158. Taking the anticipated 20% dropout rate into account, an additional 20 samples per group will be collected to bring the total number of samples per group to 99 and the total number of samples for the entire study to 198. The actual number of samples collected was 82 in the iliac group and 80 in the talar non-weight-bearing block, for a total of 162 samples, which is slightly higher than the expected number of samples without adjusting the dropout rate, but lower than the theoretical need after accounting for the dropout rate. The related calculation and design refer to the research method of Julious et al [12]. Continuous variables were presented as mean±standard deviation and categorical variables as counts and percentages. Data normality was tested using the Shapiro-Wilk test, and categorical variables were compared between the 2 groups using the chi-square test or Fisher's exact test. Continuous variables were compared using the Mann-Whitney test if they were not normally distributed. Test-retest analysis of variance was used to compare continuous variables between the 2 groups. *P* values <0.05 were considered statistically significant.

Results

Comparison of General Data, Preoperative Pain Level, and Ankle Joint Function

Detailed baseline data were compared between the 2 groups of surgical patients to ensure the objectivity and validity of subsequent efficacy comparisons. The general data, preoperative pain level, and ankle joint function of patients in the iliac periosteal bone autograft group were approximately similar to those in the talus non-weight-bearing group, and there was no statistically significant difference, including age, sex, etiology, BMI, side, follow-up year and month, duration of onset, preoperative VAS score, AOFAS score, and ankle joint range of motion in the 2 groups. This similarity ensured that subsequent comparisons of surgical outcomes were not biased by baseline differences, allowing a fair evaluation of the actual impact of the 2 surgical approaches on patient recovery (**Table 1**).

Comparison of Perioperative Outcomes Between the 2 Groups

We compared and analyzed the differences in perioperative parameters between 2 different surgical methods: the iliac periosteal bone autograft group and the talus non-weight-bearing group. The results showed that the incision length, operation time, intraoperative blood loss, and hospital stay in the talus non-weight-bearing group were significantly better than those in the iliac periosteal bone autograft group, which showed that the average incision length in the talus non-weight-bearing group was 5.36 cm, which was significantly shorter than 9.49 cm in the iliac periosteal bone autograft group (mean±SD 9.49±1.03 5.36±1.09 *t*=24.683, *P*=0.000); the average operation time in the non-weight-bearing area of talus group was 71.75 minutes, which was significantly less than the 88.87 minutes in the iliac group (mean±SD 88.87±9.53 71.75±9.70 *t*=11.327, *P*=0.000); the average intraoperative blood loss in the non-weight-bearing area of talus group was 50.58 ml, which was significantly lower than 107.78 ml in the iliac group (mean±SD 107.78±19.70 50.58±14.76 *t*=20.95, *P*=0.000); the average hospital stay in the non-weight-bearing area of the talus group was 6.41 days, which was significantly shorter than the 8.54 days in iliac periosteal bone autograft group (mean±SD 8.54±2.12 6.41±1.67, *t*=7.109, *P*=0.000). In addition, the incidence of postoperative donor site paresthesia in the talus non-weight-bearing group was 0%, which was significantly lower than 7.32% in the iliac periosteal bone autograft group (χ^2=6.079, *P*=0.014). However, no statistically significant differences were found between the 2 groups in the number of fluoroscopies, local swelling at 6 months, increasing pain, and wound infection. In summary, the talus non-weight-bearing approach caused less trauma and faster recovery in key perioperative measures and was therefore considered a superior surgical option in this study (**Table 2**).

Table 1. Comparison of general data, preoperative pain level, and ankle joint function.

	Group (mean±SD)/(%)		χ^2/t	Effect	*P*
	Iliac periosteal bone autograft group (n=82)	Talus non-weight-bearing group (n=80)			
Sex (Male)	48 (58.54)	37 (46.25)	2.451	0.123	0.117
Side (right)	51 (62.20)	40 (50.00)	2.446	0.123	0.118
Causes (sports injuries)	61 (74.39)	57 (71.25)	0.202	0.035	0.653
Age (years)	44.95±10.31	44.59±9.93	0.229	0.036	0.819
BMI (kg/m²)	23.47±3.19	23.70±3.63	-0.436	-0.067	0.663
Follow-up time (months)	23.74±5.06	24.59±4.12	-1.162	-0.184	0.247
Onset time (months)	37.22±8.19	38.73±6.11	-1.328	-0.209	0.186
Preoperative VAS score	4.62±0.73	4.46±0.86	1.276	0.201	0.204
AOFAS score before surgery	74.68±8.32	72.83±10.04	1.284	0.201	0.201
Preoperative plantar flexion range of motion (°)	21.68±2.81	21.63±2.88	0.129	0.018	0.897
Preoperative extension range of motion (°)	17.43±2.28	17.36±2.48	0.172	0.029	0.864

BMI – body mass index; VAS – visual analog scale; AOFAS score – ankle-hindfoot scoring system score.

Table 2. Comparison of perioperative outcomes between the 2 groups.

	Group (mean±SD)/(%)		χ^2/t	Effect	*P*
	Iliac periosteal bone autograft group (n=82)	Talus non-weight-bearing group (n=80)			
Incision length (cm)	9.49±1.03	5.36±1.09	24.683	3.895	0.000
Procedure time (min)	88.87±9.53	71.75±9.70	11.327	1.78	0.000
Intraoperative blood loss (ml)	107.78±19.70	50.58±14.76	20.95	3.286	0.000
Length of stay (D)	8.54±2.12	6.41±1.67	7.109	1.116	0.000
Number of intraoperative fluoroscopies	3.87±0.99	3.76±1.13	0.62	0.194	0.536
Donor site paresthesia (occurrence)	6 (7.32)	0 (0.00)	6.079	0.094	0.014
Six months local swelling (occurrence)	2 (2.44)	5 (6.25)	1.423	0.119	0.233
Worsening of pain (onset)	8 (9.76)	3 (3.75)	2.308	0.109	0.129
Wound infection (developed)	1 (1.22)	4 (5.00)	1.935	3.895	0.164

Comparison of Risk Indicators Between the 2 Groups

We compared risk indicators between the 2 groups to assess the performance of different surgical methods during postoperative recovery. The VAS score, AOFAS score, and ankle range of motion were similar, except that the VAS score on the first day after the operation was higher in the iliac bone group than in the talus non-weight-bearing area group (mean±SD 7.16±1.44 6.56±1.22, *t*=2.840, *P*=0.004), with no statistically significant difference. In summary, although the VAS score on the first postoperative day showed higher pain in the iliac group than in the talar non-weight-bearing group, no significant differences

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Table 3. Comparison of risk indicators between the 2 groups.

	Group (mean±SD)/(%)		*t*	Effect	*P*
	Iliac periosteal bone autograft group (n=82)	Talus non-weight-bearing group (n=80)			
VAS score (preop)	4.62±0.73	4.46±0.86	1.276	0.201	0.204
VAS score (postoperative day 1)	7.16±1.44	6.56±1.22	2.840	0.449	0.004
VAS score (3 months)	2.79±1.03	2.96±1.05	-1.041	-0.163	0.299
VAS score (12 months)	1.62±1.22	1.54±1.22	0.440	0.066	0.661
VAS score (last follow-up)	0.57±0.63	0.49±0.66	0.849	0.124	0.397
AOFAS score (preop)	74.68±8.32	72.83±10.04	1.284	0.201	0.201
AOFAS score (3 months)	83.66±5.90	83.13±6.86	0.531	0.083	0.596
AOFAS score (12 months)	88.66±3.82	89.86±4.35	-1.872	-0.293	0.063
AOFAS score (last follow-up)	93.71±2.79	93.38±3.80	0.633	0.099	0.528
Plantar flexion range of motion (preoperative)	21.68±2.81	21.63±2.88	0.129	0.018	0.897
Plantar flexion range of motion (3 months)	14.32±5.75	14.61±6.11	-0.317	-0.049	0.752
Plantar flexion range of motion (12 months)	24.49±4.05	24.35±4.52	0.204	0.033	0.838
Plantar flexion range of motion (last follow-up)	26.95±4.42	27.09±4.47	-0.195	-0.031	0.845
Extension range of motion (preoperative)	17.43±2.28	17.36±2.48	0.172	0.029	0.864
Extension range of motion (3 months)	15.07±3.11	14.59±3.21	0.977	0.152	0.330
Extension range of motion (12 months)	17.23±4.01	17.80±3.95	-0.909	-0.143	0.365
Extension range of motion (last follow-up)	19.10±3.67	19.65±3.95	-0.923	-0.144	0.358

VAS – visual analog scale; AOFAS – ankle-hindfoot scoring system.

were found between the 2 groups at other time points, as well as in AOFAS score and range of motion, indicating that the 2 surgical approaches had similar effects on long-term pain control and functional recovery (**Table 3**).

Discussion

We found that the talus non-weight-bearing group had shorter incision length, shorter operation time and hospital stay, and less intraoperative blood loss and postoperative complications than iliac periosteal bone autograft in patients with Hepple V talus osteochondral injury. Postoperative ankle joint function recovery was similar between the 2 groups.

The choice among medial malleolus osteotomy, lesion debridement, and autologous bone transplantation for patients with Hepple stage V talus osteochondral injury is controversial, and there are debates on whether to use iliac bone or take bone in the non-weight-bearing area of the talus. Medial malleolus osteotomy, debridement, and autologous bone transplantation are very mature and successful operations for Hepple stage V talus osteochondral injury in modern medicine. With the continuous improvement of surgical techniques, its indications are also expanding. Many studies have reported the application of medial malleolus osteotomy, lesion debridement, and autologous bone transplantation in Hepple stage V talus osteochondral injury, but there are different opinions on which method should be used. This article can provide a reference for clinicians on managing such patients.

Cao et al [13] studied 36 patients with osteochondral injuries of the talus and concluded that bone incision length was shorter and postoperative recovery was faster in the talus non-weight-bearing group compared with iliac periosteal bone autograft. Ma et al [14] studied 60 patients with Hepple stage V osteochondral injury of the talus and concluded that although the operation time of taking bone from the non-weight-bearing area of the talus was short, both groups had less ankle joint pain and better recovery of ankle joint function after surgery, which improved patient satisfaction. The results of this study are consistent with Ma [14] and other studies, and the operation time of taking the bone in the non-weight-bearing area of the talus group was short because the bone was taken from

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the same incision, while the iliac bone group required 2 incisions and increased anesthesia time, but both methods had good therapeutic effects. We conclude that bone extraction from the non-weight-bearing area of the talus has less intraoperative bleeding and shorter operation time and anesthesia time. In the iliac periosteal bone autograft group, 2 parts of the operation were exposed, the intraoperative time was long, and the cancellous bone of the anterior superior iliac crest was rich in blood supply, and the intraoperative bleeding would naturally be more than that in the non-weight-bearing area of the talus group. Sessler et al [14] concluded that short operation time brings many benefits, the most important of which is shortening the anesthesia time, correspondingly reducing the risk of anesthesia and the toxicity of anesthetic drugs. Yang et al [15] concluded that short operation time has many benefits, the most important of which is shortening the anesthesia time, correspondingly reducing the risk of anesthesia and the toxicity of anesthetic drugs. Yang et al [16] concluded that iliac bone harvesting increases the operation time and intraoperative blood loss, but the cancellous bone void structure under the iliac periosteum is looser and can better provide the necessary nutrition for cell differentiation in cartilage and osteogenesis, and adequate cancellous bone filling in the cyst cavity can provide mechanical stability for chondrogenesis, which can ensure effective osteogenesis and bone fusion under the cartilage, and the postoperative effect is better.

Some studies have suggested that the incidence of donor site complications is 6.7~10.8%, and the study sample size is negatively correlated with the incidence of complications [17]. In the present study, the incidence of complications was higher in iliac bone (12.2%) than in talus non-weight-bearing bone (7.5%). Among them, there were 6 cases of donor site paresthesia in the iliac bone group. Migliorini et al [18] showed that the incidence of paresthesia in the iliac surgical area after iliac bone harvesting ranged from 5% to 8.6%, which was similar to our findings. Most patients presented with paresthesia in the iliac region postoperatively at follow-up, which decreased over time. This may be related to intraoperative injury to the cutaneous nerve around the ilium [19], while bone extraction from the non-weight-bearing area of the talus showed no such complication. Kılçaslan et al [20] reported that if the graft bulge exceeded the surrounding cartilage by 1 mm, the contact pressure on it could increase by 7-fold. Therefore, when selecting the donor site, the articular surface curvature should be estimated, the area close to the recipient site curvature should be selected as far as possible, and the transplanted osteochondral surface should be attached to the surrounding cartilage as far as possible to avoid excessive bulging. This study concluded that the incidence of postoperative pain aggravation was higher in iliac bone harvesting (9.76%) than in bone harvesting from the non-weight-bearing area of the talus (3.74%). This may be because the shape of the bone column and the density of cancellous bone in the non-weight-bearing area of the talus are similar to the height of the recipient site, 2 incisions are required for iliac bone harvesting, and the patient feels more wound pain.

Our study confirmed that, except that the VAS score on the first day after surgery in the iliac bone group was higher than that in the talus non-weight-bearing area group, the 2 groups had the same effect in terms of intraoperative fluoroscopy times, postoperative VAS score, postoperative AOFAS score, and postoperative ankle range of motion, indicating that patients are satisfied with both surgical methods in terms of surgical results. Fansa et al [21] concluded that because two-thirds of the surface of the non-weight-bearing area of the talus is covered with cartilage, cartilage is removed from the non-weight-bearing surface of the ipsilateral non-weight-bearing area of the talus, avoiding damage to the normal ilium, reducing a surgical incision, shortening operation time, and the talar cartilage is more pressure-bearing than the iliac cartilage, and patients are more satisfied with this. Georgiannos et al [22] concluded that in patients with Hepple stage V osteochondral injury of the talus with giant bone cyst formation, a large amount of cancellous bone needs to be taken, while many bone defects will occur in the non-weight-bearing area of the talus, and ankle instability and donor site pain in the non-weight-bearing area of the talus will occur over time, resulting in patient dissatisfaction in the postoperative period. In this study, bone cysts > 15 mm did not occur, and both surgical methods were considered to be effective in relieving ankle pain and restoring ankle function.

This study has limitations. First, our main surgical methods were iliac periosteal bone autograft and talus non-weight-bearing surgery, which did not involve bone grafting in the non-weight-bearing area of the ipsilateral knee joint, and the effect of other surgical methods on the postoperative outcome was not clear. Second, we had a short follow-up time and failed to find long-term complications of surgical methods in the 2 groups, such as traumatic ankle osteoarthritis, which has been shown to currently account for a large proportion of ankle revision [23]. Third, the study had small sample sizes and short follow-up times. Follow-up should be continued in the future to supplement the study cases to assess the long-term advantages and disadvantages of these 2 surgical methods.

Conclusions

For patients with Hepple V talus osteochondral injury, talus non-weight-bearing surgery reduced the additional bone harvesting incision, and correspondingly reduced the operation time and intraoperative blood loss, thereby reducing the injury caused by iliac bone and bone harvesting around the bone harvesting, with a low incidence of complications. Patients in both groups were able to improve ankle joint function after surgery, and patient satisfaction was high. In general, reducing pain in talus non-weight-bearing patients early after surgery promotes early functional recovery and is more minimally invasive.

Declaration of Figures' Authenticity

All figures submitted have been created by the authors, who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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