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Original Article

Clinical efficacy of core decompression combined with free fibular graft in the treatment of femoral head necrosis

Zhixue Ou[1], Ping Zeng[2], Yunyong Zhou[1], Dong Huang[1], Changhui Xiao[1], Shanlong Shi[1], Yonghui Wang[1], Dongliang Li[1], Linxi Li[1]

[1]*Second Department of Orthopedics, Guilin TCM Hospital of China, Guilin, Guangxi Zhuang Autonomous Region, China;* [2]*Second Department of Orthopedics, The First Affiliated Hospital of Guangxi University of Traditional Chinese Medicine (Xianhu Hospital), Nanning, Guangxi Zhuang Autonomous Region, China*

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Abstract: Objective: To explore the clinical efficacy of core decompression combined with free fibular graft in the treatment of femoral head necrosis. Methods: A total of 90 patients with femoral head necrosis at phase II with 122 hip joints in total including 58 unilateral hip joints and 32 bilateral hip joints were enrolled. Sixty hip joints were treated with core decompression alone and the other 62 hip joints were treated with core decompression and free fibular graft in combination, and then they were studied retrospectively. The patients were compared in operation time, intraoperative blood loss and hospital stay, and their hip joint function, excellent and good rate before and after surgery were assessed using Harris score; their pain degree before and after surgery was assessed using visual analog score (VAS), and hip joint survival time was recorded based on a 5-year follow-up. Results: The two groups showed no difference in operation time and intraoperative blood loss (both $P>0.05$), and the observation group experienced significantly less hospitalization time than the control group ($P<0.05$). After surgery, the two groups showed significantly increased Harris score (both $P<0.05$), and the observation group showed significantly higher Harris score and significantly better excellent and good rate than the control group (both $P<0.05$). After surgery, the two groups showed significantly decreased VAS score, and the observation group showed significantly lower VAS score than the control group (both $P<0.05$). The observation group experienced significantly longer hip joint survival time than the control group ($\chi^2 = 4.864$, $P = 0.027$). Conclusion: For treatment of femoral head necrosis, core decompression combined with free fibular graft can effectively improve hip joint function, relieve postoperative pain, and prolong hip joint survival time. Core decompression combined with free fibular graft has been proved clinically efficient, so it is worthy of further clinical application.

Keywords: Core decompression, free fibular graft, femoral head necrosis, efficacy observation

Introduction

Femoral head necrosis, also known as aseptic bone necrosis, mainly refers to avascular necrosis of femoral head. Its pathogenesis is mainly as follows: the problem of blood supply to the femoral head causes death of femoral cells and aseptic inflammation, finally resulting in structure change of femoral head. With high incidence and extremely high disability rate, femoral head necrosis is a refractory bone disease and mainly occurs in people between 20 and 60 years old [1-3]. A study has shown that femoral head necrosis tended to occur in the younger people [4]. In terms of incidence of it, Japan suffered a rate of 2.51/10,000; the United States had 20 thousand new patients each year, and Germany had about 7 thousand new patients [5, 6]. The most common pathogenic types included hormone, alcohol, trauma, children and senile characteristics, and the pathogenic factors mainly included long-term use of glucocorticoid, excessive drinking, and trauma [7]. Long-term use of glucocorticoid was the most common reason for femoral head necrosis, which accounted for 57% of the pathogenic factors [8].

Clinical studies found that during the period when femoral head necrosis developed to the

advanced stage, the patients whose hip joint function was seriously limited required artificial joint replacement [9]. It was found that for young and middle-aged people, premature artificial joint replacement usually caused secondary replacement of hip joint and restoring difficulty due to patient activity and surgery [10]. Therefore, it was of great importance to diagnose and conservatively treat the disease early for prolonging the life of hip joints in young and middle-aged patients [11]. There were a variety of surgical methods for hip protection, including core decompression alone, bone transplantation, fibula or ilium graft with or without free vascular pedicle, and osteotomy [12]. Different surgical methods of femoral head necrosis had been reported at home and abroad, but their clinical efficacy was not the same [13, 14]. The short-term clinical efficacy of different surgical methods was satisfactory, but the long-term efficacy of them was rarely reported due to long follow-up period, and the common complications of different surgical methods were not the same [15]. Core decompression was the most frequently adopted method for the treatment of femoral head necrosis [16], but core decompression alone cannot completely restore the femoral head [17]. Therefore, finding a simple surgical method with small trauma, good efficacy and few complications is gradually becoming the focus of research. Some scholars combined core compression and bone transplantation in the treatment and obtained good efficacy with few complications [18]. In 2013, core compression combined with bone transplantation was first used with percutaneous dilation reamer, and it was turned out to be effective in removing sequestrum [19]. This study aimed to explore the clinical efficacy and long-term efficacy of core decompression combined with free fibular graft in the treatment of femoral head necrosis.

Materials and methods

Clinical data

This study has been approved by the Ethical Committee of The First Affiliated Hospital of Guangxi University of Traditional Chinese Medicine (Xianhu Hospital). A total of 90 patients with femoral head necrosis at phase II with 122 hip joints in total (including 58 unilateral hip joints and 32 bilateral hip joints) who were admitted to The First Affiliated Hospital of Guangxi University of Traditional Chinese Medicine (Xianhu Hospital) from March 2012 to March 2015 were enrolled. 60 hip joints were treated with core decompression alone and the other 62 hip joints were treated with core decompression combined with free fibular graft, and then they were studied retrospectively. The enrolled patients were between 18 and 75 years old with a mean age of 54.8±6.0 years, and they all signed an informed consent form.

Inclusion criteria

(1) Patients meeting the 2007 diagnosis criteria for non-traumatic necrosis of femoral head in the joint surgery of Chinese Orthopaedic Association [20]; (2) patients who had experienced stage evaluation based on the international classification criteria proposed by the Association Research Circulation Osseous (ARCO) in 1993 [21]; (3) patients who had undergone core decompression combined with free fibular graft or core decompression alone; (4) patients who had undergone surgery within 1 week after imaging diagnosis; (5) patients with complete clinical data.

Exclusion criteria

(1) Patients with severe heart and lung diseases, abnormal coagulation function or marrow function, or liver and kidney dysfunction; (2) patients who were difficult to follow up; (3) patients unwilling for cooperation; (4) pregnant women or lactating women.

Methods

The observation group was treated with core decompression combined with free fibular graft specifically as follows: the patients in horizontal position were disinfected and draped in the operative field, and then treated with surgery operations under the monitoring of X ray of a C-arm machine (Siemens Healthcare GmbH, Germany). After being narcotized through continuous epidural anesthesia combined with subarachnoid space block anesthesia, a kirschner wire (Henan Ouguan Medical Equipment Co., Ltd.) was inserted to the femoral head necrosis site from the surgical site, namely the site 2 cm under the greater trochanter of femoral head at the necrosis side. A 1 cm incision was made in the skin of insertion site, and a spiral guide wire

(Shanghai Medical Instrument Co., Ltd., China) was inserted from the insertion site skin to the site 2-3 mm under cartilage in the necrosis area between greater trochanter of femur and femoral neck. Then a cylindrical needle with a bit (Shanghai Medical Instrument Co., Ltd., China) was used to expand the tunnel along the spiral guide wire to the necrosis area, and a percutaneous dilation reamer (Sichuan National Nano Technology Co., LTD, China) was used to remove sequestrum as much as possible. The tunnel and cleaned cavity were flushed with normal saline, then impaction grafting with allogeneic cancellous bone was performed, and free fibulas were grafted and compressed under X ray of the C-arm machine to fill the cavity and the entire femoral neck decompression tunnel. Finally, excess fibulas exposed to the distal end of the large trochanteric cortex were removed, and the surgical incision was flushed and sutured. Then the operation was completed. After surgery, the patients required a crutch. Within 6 months after surgery, they were forbidden to bear weight with the affected limb. After 6 months, they could bear certain weight with the affected limb. After 1 year, they can live without crutch if their recovery was good.

The control group was treated with core decompression alone specifically as follows: The patients were treated with surgery operations under monitoring of X ray of a C-arm matchine after being narcotized as the observation group; a kirschner wire was inserted to the femoral head necrosis site from the surgical site, namely the site 2 cm under the greater trochanter of femoral head at the necrosis side. A 1 cm incision was made in the skin of insertion site, and a spiral guide wire was inserted from the insertion site skin to the site 2-3 mm under cartilage in the necrosis area between greater trochanter of femur and femoral neck. Then a cylindrical needle with a bit was used to expand the tunnel along the spiral guide wire to the necrosis area, and a percutaneous dilation reamer was used to remove sequestrum as much as possible. Moreover, impaction grafting with allogeneic cancellous bone was performed. The tunnel and cleaned cavity were flushed with normal saline and the operation was completed.

Observation indexes

Operation time: the time from skin incision to suture completion.

Intraoperative blood loss: blood loss during the period from skin incision to suture completion.

Postoperative hospital stay: the number of days in a ward from surgery completion to discharge.

The hip joint function before and 3 months after surgery was assessed using Harris score [22]: the symptom without hip joint discomfort was assessed as excellent and scored as ≥90 points; the symptom with mild discomfort and without activity limitation was assessed as good and scored as 80-89 points; the symptom with light hip joint pain was assessed as fair and scored as 70-79 points, and the symptom with severe hip joint pain and activity limitation was assessed as poor and scored as ≤69 points.

Postoperative pain: the subjective pain perception was quantified using the linear visual analogue scale (VAS) method. A scale with two stops, 0 and 10, was selected, in which 0 represented no pain and 10 represented the most severe pain experienced by the patient. The patients selected one point from 0 to 10 according to their pain, and points measured at 3 months after surgery were the patients' VAS score [23].

The disease progress was assessed comprehensively based on ARCO classification and imaging. When the disease progressed to seriously affect life quality of a patient and the patient required artificial total hip arthroplasty for replacement therapy, it was considered that core decompression combined with free fibular graft or core decompression alone failed to protect the hip [24]. Assessment was carried out by taking failed hip protection treatment as event end.

Follow-up indexes

A 5-year follow-up was performed to all enrolled patients, and the last follow-up was performed on March 31, 2019. The patients were followed up in the way of outpatient and telephone interviews every 3 months for a total of 22-63 months, with an average follow-up of 41.5±8.6 months. Failed hip protection treatment was taken as the event end in recording.

Table 1. Analysis of general data

Item	Observation group (n = 46, hip joint = 62)	Control group (n = 44, hip joint = 60)	χ^2/t	P
Gender (male/female)	26/20	22/22	0.384	0.585
Age (years)	55.0±6.5	55.1±5.8	0.122	0.903
Unilateral hip:bilateral hip	30/16	28/16	0.025	0.876
ARCO stage			0.286	0.867
IIa	17	15		
IIb	28	30		
IIc	17	15		
Etiology			0.143	0.931
Hormonal	32	30		
Alcoholic	24	25		
Idiopathic	6	5		
BMI (kg/cm^2)	25.21±3.62	24.82±3.54	0.412	0.684
Complicated diseases (yes/no)				
Hyperlipidemia	18/28	17/27	0.002	0.962
Hypertension	22/24	23/21	0.178	0.673
Coronary heart disease	10/36	9/35	0.022	0.881
Smoking history			0.406	0.524
Yes	24	20		
No	22	24		
Drinking history			0.061	0.805
Yes	20	18		
No	26	26		

Note: BMI, body mass index.

Statistical analysis

SPSS 17.0 software was adopted for Anderson-Darling test to continuous variables. Continuous variables in compliance with normal distribution were expressed in mean ± standard deviation ($\bar{x}$ ± sd), and those in compliance with homogeneity of variance were checked by independent t-test. Comparison before and after surgery was made by paired t test and expressed by t. Enumeration data were analyzed by Pearson chi-square test and expressed by χ^2. Survival analysis was performed by Kaplan-Meier analysis and Log-rank test. P<0.05 indicated significant difference.

Results

Comparison of general data

There were no significant differences in gender, age, ARCO stage, etiology, body mass index (BMI), combined disease, smoking and drinking history between the observation group (46 patients) and control group (44 patients) (all P>0.05). See **Table 1**.

Comparison between the two groups in surgery

The two groups showed no difference in operation time and intraoperative blood loss (both P>0.05), but the observation group experienced significantly less hospitalization time than the control group (P< 0.05). More details are shown in **Table 2**.

Comparison of Harris score, excellent and good rate before and after surgery

The two groups showed no difference in Harris score before surgery (P> 0.05), but showed significantly increased Harris score after surgery (P< 0.05). The observation group showed significantly higher Harris score than the control group after surgery, and significantly better excellent and good rate than the control group (both P<0.05). More details are shown in **Tables 3** and **4**.

Comparison of VAS score before and after surgery

The two groups showed no difference in VAS score before surgery (P>0.05), but showed significantly decreased VAS score after surgery (P<0.05). The observation group showed significantly lower VAS score than the control group after surgery (P<0.05). More details are shown in **Table 5**.

Comparison of hip joint survival rate after surgery

After being treated with the two surgical methods, 25 hip joints out of the total enrolled 122 hip joints required artificial replacement for hip joint protection due to disease progression, and experienced failure, including 3 hip joints in stage IIa, 10 hip joints in stage IIb and 12 hip joints in stage IIc. The hip protection failure rate was 20.49%, and the mean hip joint survival

Table 2. Comparisons of surgical conditions between the two groups

Item	Observation group	Control group	t	P
Operation time (min)	84.47±8.97	81.89±12.76	1.298	0.197
Intraoperative blood loss (mL)	95.51±7.39	91.54±12.48	1.703	0.092
Hospitalization time (d)	5.61±0.67	7.04±0.81	9.024	<0.001

Table 3. Comparison of Harris score between two groups before and after operation

Item	Observation group	Control group	t	P
Before operation	72.87±4.39	72.62±5.10	0.295	0.768
After operation	90.40±7.39[a]	86.35±8.07[a]	2.895	0.005

Note: Compared with before operation, [a]P<0.05.

Table 4. Comparison of excellent and good rate between two groups

Item	Observation group (n = 46, hip joint = 62)	Control group (n = 44, hip joint = 60)	χ^2	P
Evaluation of hip joint function			9.788	0.020
Excellent	20	13		
Good	30	20		
Fair	11	22		
Poor	1	5		
Excellent and good rate	80.64%	55.00%	9.221	0.002

Table 5. Comparison of VAS score between two groups before and after operation

Item	Observation group	Control group	t	P
Before operation	5.42±1.25	5.32±1.05	0.464	0.643
After operation	2.07±1.16[a]	2.84±1.26[a]	3.541	0.001

Note: Compared with before operation, [a]P<0.05.

time was 42.68±5.70 months. In the observation group with 62 hip joints, there were 10 hip joints that had experienced failed hip protection, including 1 hip joint in stage IIa, 4 hip joints in IIb and 5 hip joints in stage IIc. In the control group with 60 hip joints, there were 15 hip joints that had experienced failed hip protection, including 2 hip joints in stage IIa, 6 hip joints in IIb and 7 hip joints in stage IIc, so the two groups showed no significant difference in hip protection failure rate (P>0.05). The observation group experienced longer hip joint survival time than the control group (46.900± 1.130, 95% CI 44.685-49.115 vs. 39.867± 1.323, 95% CI 37.273-42.460), respectively, and the difference was significant (χ^2 = 4.864, P = 0.027). More details are shown in **Table 6** and **Figure 1**.

Discussion

For treatment of femoral head necrosis, core decompression alone can remove lesions, but it destroys the normal structures of bone tissues and bone trabecula, which leads to the lack of support in bone plates under cartilage and increases the risks of collapse and fracture of femoral head. Core decompression combined with bone transplantation can provide support to bone plates and reduce the risk of collapse and fracture [25]. Therefore, core decompression combined with bone transplantation was widely adopted in the treatment of femoral head necrosis in stage ARCO I-III and patients who had experienced failed core decompression [26]. A previous study revealed that core decompression combined with bone transplantation was effective with small surgical trauma and rapid recovery effects [18]. This study also found that although core decompression combined with bone transplantation showed no significant difference with core decompression alone in operation time and blood loss, it can shorten hospitalization time, so the combination method contributed to faster recovery.

In terms of clinical efficacy, a foreign study used core decompression combined with bone transplantation to treat 26 patients with hip joint in stage ARCO I-III, and it turned out that the Harris score of the patients after surgery (85 points) was significantly higher than that before treatment (41 points) [27]. Another study by Yao et al. found that the Harris score of 8 hip joints was increased to 80.5±7.6 points from 54.5±8.2 points after they were treated with core decompression and bone transplantation in combination based on a 36.6-month

Table 6. Comparisons of hip protection failure rate between two groups

Item	Observation group (n = 46, hip joint = 62)	Control group (n = 44, hip joint = 60)	χ^2	P
IIa	1	2		
IIb	4	6		
IIc	5	7		
Hip protection failure rate	16.13%	25.00%	1.473	0.225

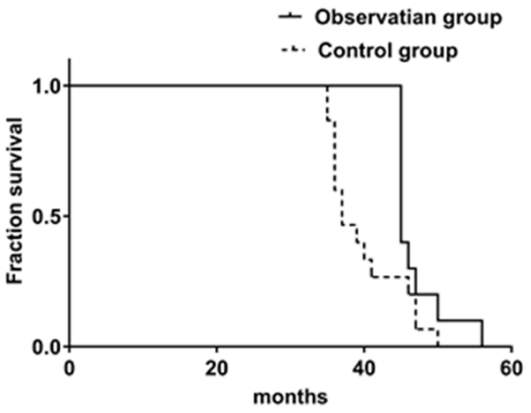

Figure 1. Comparison of hip survival curve between two groups.

follow-up [28]. This study also found that patients showed significantly higher Harris score after being treated with core decompression and bone transplantation in combination, and patients treated with core decompression and bone transplantation in combination showed significantly higher Harris score than those treated with core decompression alone, which indicated that core decompression combined with bone transplantation can significantly improve hip joint function. Feng et al. used core decompression combined with bone transplantation to treat 46 hip joints and followed them up for 26 months, and they found that the excellent and good rate of hip joints in stage lower than ARCO IIc was 78.0%, and that of the hip joints in stage higher than ARCO IIc was 52.6%, and 4 hip joints required hip replacement during the follow-up period, showing a hip protection failure rate of 8.70% [29]. This study showed that the excellent and good rate of patients treated with core decompression and bone transplantation in combination was higher than the patients treated with core decompression alone, which indicated that core decompression combined with bone transplantation can improve hip joint function more significantly.

In terms of pain relief, a foreign study found that the Harris score of 132 hip joints was increased after they were treated with core decompression and bone transplantation in combination and their VAS score was also decreased to 1.4±2.0 from 6.3±1.4 [30]. Hu et al. compared the allogeneic fibula transplantation and core decompression, and they found that VAS score showed more significant decrease after allogeneic fibula transplantation than the VAS score after core decompression [31]. This study also found that hip joints showed significantly lower VAS score after surgery, and those treated in a combination way showed a more significant decrease than those treated with core decompression alone, which indicated that core decompression combined with bone transplantation can help relieve the pain caused by femoral head necrosis.

In terms of hip joint survival time, a previous study by Zuo et al. used core decompression combined with bone transplantation to treat 158 hip joints and followed them up for 31 months in average, and they found that 31 hip joints required hip replacement during the follow-up period, showing a hip protection failure rate of 19.6% [32]. Another study used core decompression combined with bone transplantation to treat 132 hip joints in stage II-III, and followed them up for 48.5 months, and they found that the hip protection rate was 90.9%, with 12 hip joints requiring hip replacement due to disease progression [30]. This study showed a hip protection failure rate of 20.49% with 25 hip joints out of 122 that experienced failed hip protection. This study also found that hip joints treated with core decompression and bone transplantation experienced longer hip joint survival time than those treated with core decompression alone, which indicated that core decompression combined with bone transplantation can protect hip joint better.

The sample size of this study is small, so it is still necessary to further expand the sample size for research, and further increase the observation time to study the postoperative condition of patients treated with core decompression combined with bone transplantation.

In summary, for treatment of femoral head necrosis, core decompression combined with free fibular graft can effectively improve hip joint function, relieve postoperative pain, and prolong hip joint survival time. Core decompression combined with free fibular graft has been proved clinically efficient, so it is worthy of further clinical application.

Disclosure of conflict of interest

None.

Address correspondence to: Ping Zeng, Second Department of Orthopedics, The First Affiliated Hospital of Guangxi University of Traditional Chinese Medicine, No. 327 Xianhu Avenue, Nanning 530023, Guangxi Zhuang Autonomous Region, China. Tel: +86-0771-5361264; Fax: +86-0771-5361264; E-mail: zengping58t@163.com

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