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Research Article

Multivariate Analysis of Femoral Adductor Muscle Contracture after Total Hip Arthroplasty in Patients with Avascular Necrosis of Femoral Head

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Abstract: ***Objective:*** This study is to investigate the risk factors of femoral head contracture after total hip arthroplasty (THA) in patients with avascular necrosis of femoral head. ***Methods:*** Retrospective analysis was performed in 361 cases of femoral head necrosis patients taking THA from September 2016 to December 2017. A total of 179 patients with no significant preoperative adductor muscle contraction were finally enrolled in this study. These 179 patients were further divided into two groups: contracture group (64 cases) and noncompaction group (115 cases). The chi-square test was used to compare the differences between the two groups. Risk factors were identified by logistic regression analysis. ***Results:*** Of the patients included, 64 patients (35.75%) developed into end adductor muscle contracture. There were significant differences in limb shortening, surgical history, whether traction, surgical approach, surgical methods, and functional training between the two groups (P<0.05). Logistic regression analysis showed that shortness of extremity, surgical approach, effective traction, surgical history, and etiology were the factors affecting femoral head contracture after THA in patients with avascular necrosis of femoral head. ***Conclusions:*** Preoperative traction therapy, surgical methods, and postoperative functional training are the factors that affect the adductor muscle contraction after THA.

Keywords: Femoral head necrosis; Total hip arthroplasty; Risk factors; Multivariate analysis

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1 Introduction

Avascular necrosis of the femoral head refers to a series of pathological processes including disruption of bone circulation, death of active components of bone, and subsequent repair for various reasons (mechanical, biological, etc)[1]. Suffering from local pain and impaired mobility, patients with avascular necrosis of the femoral head usually have low life quality. As total hip arthroplasty (THA) is being widely applied via more advanced approaches and developed equipments, THA related complications greatly decrease[2]. Contracture of the vastus medialis, which is a rare complication associated with THA, does not receive a full coverage in the academic cycle.

Previously, we found that some patients with avascular necrosis of the femoral head are accompanied by contracture of the vastus medialis[3]. However, after THA, almost all patients had a risk of contracture of the vastus medialis no matter there is preoperative contracture or not. If contracture happens postoperatively, the patients are very likely to be unsatisfactory with the surgery or even consider

the surgery as failure. In some severe circumstances, there will be an imbalance of muscle strength around the hip joint, leading to limited mobility of the hip joint. Besides the impairment of patients' life quality, dislocation of the hip joint might also occur. The Harris hip score was 89.1 ± 4.1 for post-THA patients in our hospital, which agrees with the score reported in other studies[4-5]. This means that the contracture of the vastus medialis in our patients is unlikely caused by low skills of the surgeon. In the present study, to identify the causes of THA-associated complications, we analyzed potential factors affecting the contracture of the vastus medialis. The target patients studied were those who had no preoperative contracture but developed the contracture after the surgery. After a preliminary screening of the risk factors, binary logistic regression was performed to detect risk factors.

2 Materials and methods

2.1 Subjects

From September 2016 to December 2017, a total of 361 cases of femoral head necrosis patients in hospital had undertaken THA. Retrospective analysis of clinical data for these patients including age, sex, surgical history and so on (table 1) together with follow-up for one year was performed to observe whether the postoperative femoral adductor contracture occurred.

Table 1. Variables assignment table

	variables	code	assignment
A[1] factors	sex	X1	male = 0; female = 1
	age	X2	≤65 years = 0; >65 years = 1
	cause of necrosis of femoral head	X3	trauma = 0; non-traumatic = 1
	with or without osteoporosis	X4	no or mild = 0; moderate above = 1
	with or without medical complications	X5	no medical = 0;
	one or more = 1	X5	no medical = 0;
	shortness of limb	X6	≤ 2cm = 0; > 2cm = 1
	surgical history	X7	No = 0; yes = 1
	surgical history	X7	No = 0; yes = 1
B[2] factors	preoperative effective traction	X8	yes = 0; no or invalid = 1
	surgical approach	X9	lateral = 0; posterolateral = 1
	prosthesis origin	X10	China = 0; other = 1
	surgical method	X11	total hip arthroplasty = 0; artificial femoral head replacement = 1
	prosthetic material	X12	biotype = 0; bone cement type = 1
	postoperative functional exercise	X13	yes = 0; no = 1

1: A factors: non-controllable factors; 2: B factors: controllable factors.

The inclusion criteria was as follows: patients who were confirmed as avascular necrosis of the femoral head; patients who received the first THA; patients who were with integrity medical records without missing; patients with the follow-up time of above 6 months. Patients without or with incomplete medical records, patients with concurrent neurological disorders which made them incapable of cooperation, and patients combined with other dysfunction of the affected limb or being on concurrent therapies that might interfere were excluded. This study was approved by the ethics committee of Guangxi Orthopaedics and Traumatology Hospital, the First Affiliated Hospital of Guangxi Medical University Hospital, and Jiangbin Hospital.

2.2 Observation indicators

The risk factors were divided into controllable and non-controllable factors. Non-controllable factors included the followings: age, gender, etiology, degree of osteoporosis, complications of internal medicine, degree of limb shortening, and history of surgeries for the same site. Controllable factors included the followings: having received preoperative traction therapy or not, surgical approach, prosthesis material & type, producing area of prosthesis, and doing postoperative functional training or not.

2.3 Statistical analysis

Statistical analyses were performed using SPSS 21.0 (SPSS Inc, Chicago, Illinois, USA) software. For categorical data, the χ^2 test was performed. Binary logistic regression was conducted to identify risk factors. All P values were two-sided and $P<0.05$ indicated significant difference.

3 Results

3.1 Clinical data

Of the 361 patients undergoing THR in our hospital, 179 cases were without preoperative contracture of the vastus medialis and receiving unilateral surgery were included. There were 92 males and 87 females, aged between 54 years to 91 years (average, 67.4 ± 7.1 years). Depending on the presence or absence of postoperative contracture of the vastus medialis, they were divided into the contracture group (n=64) and non-contracture group (n=115). All the 179 cases included were followed up for more than one year with completely collected data. Contracture of the vastus medialis occurred in 64 cases postoperatively, with the incidence of 35.7%.

3.2 Non-controllable factors analysis

In order to detect the differences between non-contracture group and contracture group, a chi-squared test was performed. Among the non-controllable factors, sex, age, cause of necrosis of femoral head, osteoporosis, medical complications in the two groups were not found to be significantly different (Table 2. P>0.05). However, there were significant differences in shortness of limb and history of surgery between the two groups (Table 2. P<0.05). The result suggested that patients with a history of surgery or limb shortening require more attention after THA to prevent the occurrence of adductor muscle contracture.

Table 2. The comparison between the non-contracture group and the contracture group

			non-contracture group(n)	contracture group(n)	χ^2(P)
A[1] factors	sex	male	56	59	0.94(0.34)
		female	36	28	
	age	≤65 years	54	61	2.04(0.16)
		>65 years	23	41	
	cause of necrosis of femoral head	trauma	48	67	2.55(0.11)
		non-traumatic	19	45	
	osteoporosis	no or mild	57	58	0.12(0.73)
		moderate above	30	34	
	medical complications	no	46	69	3.26(0.07)
		one or more	17	47	
	shortness of limb	⩽ 2 cm	64	51	9.83(0.00)
		>2 cm	14	50	
	surgical history	yes	39	25	28.19(0.00)
		no	107	8	
	preoperative effective traction	yes	87	28	40.70(0.00)
		no	17	47	
B[2] factors	surgical approach	lateral	82	33	23.04(0.00)
		posterolatera	17	47	
	prosthesis origin	China	52	63	0.38(0.54)
		other	32	32	
	surgical method	total hip arthroplasty	80	35	4.81(0.00)
		artificial femoral head replacement	34	30	
	prosthetic material	biotype	60	55	0.05(0.94)
		bone cement type	33	31	
	postoperative functional exercise	yes	88	27	29.67(0.02)
		no	38	26	

1: A factors: non-controllable factors; 2: B factors: controllable factors.

3.3 Controllable factors analysis

To further unravel the factors that could induce adductor contracture so as to reduce the incidence of adductor contracture after THA, controllable factors were analyzed. Of the controllable factors, having received preoperative traction therapy or not, surgical approach, surgical methods, and doing postoperative functional training or not were significantly different between non-contracture group and contracture group (Table 2, P<0.05). In term of the result, it is possible to assume that these factors are of great importance to the influence of adductor contracture after THA.

3.4 Risk factors analysis

In order to elucidate the risk factors for adductor

contracture after THA, binary logistic regression was performed. As shown by binary logistic regression, among the non-controllable factors, etiology, degree of limb shortening, and surgical history were independent risk factors for postoperative contracture. Surgical history was the most significant (*OR*=6.342), which was followed by degree of limb shortening (*OR*=4.354) and etiology (*OR*=3.769). Among the controllable factors, having received preoperative traction therapy or not, surgical approach, and postoperative functional training were independent risk factors. Having received preoperative traction therapy or not was the most significant (*OR*=13.302), which was followed by surgical approach (*OR*=5.862) and doing postoperative functional training or not (*OR*=3.255).Instead, the surgical method was not a risk factor (*P*>0.05). Together, the results indicated that we could reduce the incidence of adductor muscle contracture after THA by means of changing the controllable factors.

4 Discussion

THR is widely used in the treatment of femoral head. arthroplasty with artificial hip joint not only reduces local pain and restores the function, but also prevents hip joint deformity[6]. It is reported[7] that there are about 500 thousand people receiving THA each year around the world. In China, about 100 thousand people receive THA each year. THA-associated complications can be more properly managed because of advances in surgical technique, equipments, prosthesis design & material, and perioperative treatment protocols[8]. However, according to a previous study[9], severe contracture of vastus medialis after THA is one of the major reasons leading to dislocation of the prosthesis. Moreover, once femoral head necrosis aggravated, there will be collapse of the femoral head, leading to limb shortening, limited mobility, and exacerbated pain[10]. Anesthetics and muscle relaxants are used during THA to induce the relaxation of the vastus medialis for the convenience of surgical procedures and prosthesis placement. Shortening of the limb can be redressed by hip prosthesis and relative stretching of the vastus medialis. This may probably lead to acute or persistent strain of the vastus medialis and hence result in local edema or aseptic inflammation of local muscles and tendons. As the degenerative fibrosis of muscular facia occurs with the formation of cord-like or nodular lesions, the contracture of the vastus medialis will be aggravated. At early THA stage, the contracture may be neglected in the presence of wound pain or because of forbidden movement. The conventional Harris score can provide a general assessment of the effect of THA, however, the pain score does not indicate the position of pain and the mobility of the affected limb is assigned a very low weight. This is another reason for neglecting contracture of the vastus medialis. In this study, 64 patients had postoperative contracture of the vastus medialis, with the incidence of 35.75%, which indicates that post-THR contracture of the vastus medialis is a common clinical symptom that deserves more attention.

We performed χ^2 test and binary logistic regression to analyze influencing factors for postoperative contracture of the vastus medialis. This result showed that age, gender, etiology, degree of osteoporosis, concurrent internal medicine diseases, producing area of prosthesis (China/other), and prosthesis material (biological/bone cement) have little impact on post-THR contracture of the vastus medialis. The major risk factors identified were degree of limb shortening, history of previous surgery for the same site (typical internal fixation using multiple hollow nails and locking compression plate), having received preoperative traction therapy or not, surgical approach (anterolateral/posterolateral), prosthesis type (total/partial), and doing postoperative functional training or not, these are consistent with previous reports [11,12]. As shown in Table 3, etiology, limb shortening, history of previous surgery for the same site, having received preoperative traction therapy or not, surgical approach and doing postoperative functional training or not were the independent risk factors.

Etiology and limb shortening observed in avascular necrosis of the femoral can be divided into traumatic and non-traumatic type. The non-traumatic type is more common, typically as a result of long-term alcohol use or long-term hormone use. The etiology distribution in the present study was consistent with other studies[13]. Patients of the traumatic type who have already received either internal fixation or conservative treatment all face the risk of severe limb shortening, as opposed to a much lower risk for the non-traumatic type[14]. Among our cases, the most severe limb shortening was found in

the traumatic type, by as much as about 5.2 cm in length. Therefore, etiology and limb shortening both have impact on post-THA contracture of the vastus medialis. The more severe the limb shortening, the greater the postoperative stretching of the vastus medialis so as to restore the normal limb length by THA, and hence the greater the risk of contracture will be.

Table 3. Analysis of risk factors of adductor muscle contracture after total hip replacement

		B	*SE*	*Wald*	*P*	*OR*	95%*CI*[*]	
							lower	upper
A[1] factors	cause of necrosis of femoral head	1.33	0.53	6.22	0.01	3.77	1.33	10.70
	shortness of limb	1.47	0.51	8.43	0.00	4.35	1.61	11.75
	surgical history of	1.85	0.64	8.29	0.00	6.34	1.80	22.30
B[2] factors	preoperative traction	2.59	0.53	24.11	0.00	13.30	4.74	37.37
	surgical approach	1.77	0.48	13.79	0.00	5.86	2.31	14.91
	postoperative functional exercise	1.18	0.51	5.35	0.02	3.26	1.20	8.85
	surgical method	0.65	0.47	1.94	0.16	1.91	0.77	4.77

[*]: 95%*CI*: 95% confidence interval; [1]: A factors: non-controllable factors; [2]: B factors: controllable factors.

For those with a history of previous surgery for the same site, the vastus medialis is usually tensed with limited mobility of hip joint due to cicatricial contracture of the lateral incision, pain after the primary surgery and bed rest for bone union. Secondary surgery requires considerable stripping and exposure of soft tissues, which produces an adverse impact on the vastus medialis and leads to contracture[15].

The objective of preoperative traction therapy is to induce the relaxation of the soft tissues surrounding the hip joint. This is considered to be conducive to the tractive reduction of the hip joint after prosthesis placement. As the vastus medialis is relaxed with traction, it will be easier to perform surgical reduction and postoperative contracture is less likely to happen if attention is paid to avoid over-stretching the affected limb. However, some patients show low compliance with the traction therapy due to fear of the risk of nerve injury, infection-induced osteomyelitis[16] and endurable pain. These patients are prone to injury of the vastus medialis under strong traction after THA and therefore to postoperative contracture.

Posterolateral[17] and lateral approaches[18] are most commonly used for THA, and each approach has different impact on the vastus medialis, leading to varying degree of postoperative balancing of soft tissues[19]. The posterolateral approach is associated with higher difficulty to expose the anterior acetabulum and the surgery must be assisted with the hook and traction. Taking the proximal femur as the axis, the surgical site under the posterolateral approach is symmetrical with the vastus medialis. The vastus medialis may suffer considerable counterforce, thus leading to contracture of the vastus medialis.

Postoperative functional training usually includes isometric contraction of the quadriceps and active flexion and extension of the ankle joint, which are followed by flexion and extension of the hip joint and abduction of the lower limbs. The patients can stand and walk 3-7 days postoperatively with the protective devices. Some studies reported[20-21] that both active and passive functional training can help with the lysis of adhesion and relieve muscular contracture. In the present study, some patients did not do the functional training for various reasons and stayed in bed for a long time, which could result in contracture of the vastus medialis.

The risk factors were further validated by binary logistic regression. Although the surgical method, total or partial hip arthroplasty, it was not significant in the binary logistic regression (P>0.05). This may be explained by the factors of incision, exposure and operated scope in total or partial hip arthroplasty. THA entails longer incision and larger scope of exposure for the manipulation of the acetabulum. The choice of surgical methods may have greater impact on the postoperative hip joint function. It is generally believed that THA is superior to the partial hip replacement in terms of outcomes[22-23] and the incidence of dislocation and pain[24].

To conclude, contracture of the vastus medialis following THA for avascular necrosis of the femoral head can be affected by the following risk factors: degree of limb shortening, surgical approach, having received preoperative traction therapy or not, history of previous surgery for the same time. Excluding the

non-controllable factors, post-THA complications can be reduced by preoperative traction therapy, proper choice of surgical approach and postoperative functional training. For those with preoperative severe contracture of the vastus medialis, dissection of the vastus medialis can be performed simultaneously during THA to reduce the symptoms[25] and to improve the outcomes.

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Disclosures

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