

Pulmonary hypertension could be a risk for deep vein thrombosis in lower extremities after joint replacement surgery

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SUMMARY

A background of Pulmonary Hypertension (PH) indicates a progressive elevation of pulmonary vascular resistance, leading to overfilling, elevation of venous pressure, congestion in various organs, and edema in the venous system. This study aimed to investigate whether PH is a risk factor for deep vein thrombosis (DVT) of the lower extremities after hip and knee replacement surgery.

METHODS: A total of 238 patients who received joint replacement of lower extremities in our department of orthopedics from January 2009 to January 2012 were examined by echocardiography and Color Doppler flow imaging (CDFI) of the lower extremities. Based on pulmonary artery pressure (PAP), the patients were divided into a normal PAP group (n=214) and PH group (n=24). All the patients were re-examined by CDFI during post-operative care.

RESULTS: Among the 238 patients, 18 had DVT in the lower extremities after the operation. DVT total incidence rate was 7.56% (18/238). In the PH group, 11 patients had DVT (45.83%, 11/24), but in the normal PAP group, only 7 had DVT (3.27%, 7/214). The incidence of DVT was significantly lower in the normal PAP group than in the PH group ($P < 0.01$). In addition, there was a positive correlation between PAP and the incidence of DVT.

CONCLUSION: PH could be a high-risk factor for the occurrence of DVT in patient's lower extremities after joint replacement surgeries.

KEYWORDS: Hypertension, Pulmonary. Arthroplasty, Replacement. Venous Thrombosis. Risk factors.

INTRODUCTION

Deep venous thrombosis (DVT) is one of the major complications after joint replacement¹. DVT affects the patient's postoperative rehabilitation, and it may even lead to fatal pulmonary embolism (PE)². Effective preventive measures could lower the risk of venous thromboembolism (VTE), alleviate pain, and reduce

health care costs³. The Chinese Orthopedic Association (COA) specially formulated guidelines for the prevention of VTE in major orthopedic surgeries in order to guide clinical thrombosis prevention in orthopedic surgery. However, it remains unclear whether pulmonary hypertension (PH) is a risk factor of DVT.

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In this retrospective study, we enrolled patients who underwent hip and/or joint replacement surgeries in the First Affiliation Hospital of Xinjiang Medical University from January 2009 to January 2012 and examined the correlation of PH with DVT after hip or knee replacement surgeries.

METHODS

Patients

This study was approved by the Institute of Ethics Committee of the First Affiliation Hospital of Xinjiang Medical University (No. 20130325-01), and all patients signed the consent form. Among all the patients who underwent joint replacement at our orthopedic center from January 2009 to January 2012, 238 received preoperative echocardiography, venous CDFI and postoperative CDFI examinations of the lower extremities. The patients included 89 males and 149 females, aged 54 to 92 (average age 65.9 years). There were 149 cases of total knee replacement surgery in knee joint osteoarthritis, 74 cases of total joint replacement in hip joint osteoarthritis, and 15 cases of hip replacement surgeries after hip fracture (10 total joint replacements, and 5 semi-joint replacements). The 238 patients were divided into two groups: the normal PAP group and PH group, according to their preoperative pulmonary artery pressure (PAP).

Diagnostic methods

Normal mean pulmonary artery pressure (mPAP) under quiescent conditions detected by Doppler echocardiography is 20-35 mmHg. A mPAP of 36-50 mmHg indicates mild PH, 51-80 mmHg indicates moderate PH, and > 81 mmHg is diagnosed as severe PH.

The main diagnostic criteria of lower extremity DVT by Doppler echocardiography are as follows: (1) thrombus in the Lumen of vein, the fact that the form of vascular cavities (especially the anterior and posterior diameter) shows little or no change after the probe is pressurized, which is the most reliable sign for diagnosing DVT; (2) disappearance of normal Lumen of vein and emergence of solid echoes of low or ranging intensity; (3) completely obstructed Lumen of vein, no signals of blood flow detected by color and pulse Doppler at the diseased region. Zero increase of blood flow after pressurization of distal limb indicates that the thrombus is located at the spot under examination or at the distal end⁴.

Statistical analysis

Data were analyzed using SPSS 17.0 software (SPSS Inc., Chicago, IL, USA). The data were expressed as the mean±SD and the comparison between the two groups was performed using the χ^2 test. A $P < 0.05$ was considered statistically significant.

RESULTS

Amongst the 238 patients, 214 were in the normal PAP group (84 males, 130 females, average age 65.63 years), and 24 patients were in the PH group (5 males, 19 females, average age 68.3 years). A total of 18 cases of lower extremity DVT occurred in both groups; the total occurrence of DVT was 7.56% (18/238). There were 11 cases of postoperative DVT in lower extremities in the PH group (5 males and 6 females, average age 68.7 years, 7 knee replacements, 3 hip replacements, 1 semi-hip joint replacement after hip fracture), which is equivalent to 45.83% (11/24). There were 7 postoperative DVT cases in the normal PAP group (3 males and 4 females, average age 62.4 years, 4 knee replacements and 3 hip replacements), equivalent to 3.27% (7/214).

Statistical analysis showed that the incidence of DVT in the PH group was significantly higher than that in the normal PAP group ($\chi^2=65.776$, $P < 0.01$, Table 1). According to the mPAP values shown in the echocardiography, the incidence of DVT in the normal, mild, moderate, and severe PH patients was calculated with the application of the Cochran Armitage trend test. The results showed that the incidence of postoperative DVT was inclined to increase with the elevation of preoperative mPAP in patients ($\chi^2=49.996$, $P < 0.01$, Table 2).

DISCUSSION

The current diagnostic standard of PH is mPAP>25 mmHg at sea level and under a quiescent

TABLE 1. COMPARISON OF THE CASES OF POSTOPERATIVE LOWER EXTREMITIES DVT IN TWO GROUPS

	PH (percentage)	Non-PH (percentage)
DVT	11 (45.83%)	7 (3.27%)
Non-DVT	13 (54.17%)	207 (96.73)
Total	24	214

TABLE 2. THE RELATIONSHIP BETWEEN MPAP AND THE INCIDENCE OF DVT

	mPAP (mmHg)				Total
	≤35 (normal)	36~50 (mild PH)	50~80 (moderate PH)	≥81(severe PH)	
DVT	7	7	3	1	18
Non-DVT	207	12	1	0	220
Total	214	19	4	1	238
Incidence (%)	3.27	36.84	75	100	7.56

condition⁵. According to “Guidelines for the diagnosis and treatment of pulmonary hypertension” published by the European Respiratory Society and the European Society of Cardiology in 2009⁶, PH is classified into five categories: (1) Pulmonary arterial hypertension (PAH); (2) PH due to left heart disease; (3) PH due to lung diseases and/or hypoxia; (4) Chronic thromboembolic PH; and (5) PH with unclear and/or miscellaneous. Among different types of PH, the typical clinical manifestation is the constant elevation of PAP along with the continuous rise of venous pressure of the right ventricular, which would lead to overfilling, elevation of venous pressure, congestion in various organs as well as edema in the systemic venous system, or even right heart failure^{5,7}. Meanwhile, hypoxia could be aggravated due to the lack of effective circulating blood in the systemic circulation. Chronic hypoxia could also cause secondary polycythemia, increased blood viscosity, and elevated circulation resistance. Any cause leading to vein injury, stagnant or slow venous blood flow or hypercoagulable state of blood could potentially be a risk factor of venous thromboembolism (VTE)⁸. Additionally, total knee replacement (TKR) or total hip replacement (THR) is a strong stimulating factor for DVT⁹. Therefore, for patients with PH who also have the aforementioned risk factors for thrombosis, surgeons should be highly sensitive to the incidence of DVT in the perioperative period. A previous report compared patients with PH after THR or TKA and patients without PH and undergoing these surgeries and found that the preoperative mortality among patients with PH was 3.7 and 4.6 times higher for those undergoing THA or TKA, respectively¹⁰.

In 2009, the Chinese Orthopedic Association published a guideline for VTE prevention to guide the clinical practice, which confirmed that major orthopedic surgery is a very high-risk factor of VTE¹¹, especially

of THR and TKR. The guidelines also summarized other common secondary risk factors including age, trauma, history of VTE, obesity, paralysis, immobility, application of tourniquet in surgery, general anesthesia, malignant neoplasm, central vein catheterization, chronic venous valvular incompetence. However, there is no report on PH as a risk factor of DVT.

During many years of clinical work, we examined clinical data of DVT patients after joint replacement and found abnormalities in the preoperative cardiac echocardiography of most DVT patients. Notably, PAP values increased to different extents, which led us to explore whether postoperative DVT was correlated to the changes in hemodynamics and hypercoagulable state that caused by elevated PAP. In this study, we analyzed the clinical data of 238 patients during three years. By comparing the incidence of postoperative DVT between the normal PAP group and PH group, we found that patients with PH had a significantly higher occurrence of DVT in the lower extremities compared with the normal PAP group. We believe that orthopedic surgeons should pay close attention to patients diagnosed with PH in preoperative echocardiography.

Among different means of clinical examination, right heart catheterization is a golden diagnostic criterion of PH¹². However, this cannot be applied as a routine test because of its invasiveness. Doppler echocardiography is the most commonly used non-invasive, convenient, accurate, and reproducible method of examination. Many studies showed that PH diagnosis by echocardiography maintained a good correlation with the measured PAP from the right heart catheter¹³. In this study, we found that the risk of postoperative DVT was likely to increase with the rise of mPAP values in preoperative echocardiography, which indicated the correlation between postoperative DVT and preoperative mPAP value in PH patients. In fact, mPAP value is an exclusive risk factor for COPD¹⁴.

In the intermediate or late stage of heart diseases, the prognosis could be deteriorated if the diseases were accompanied by PH¹⁵. Among the 11 postoperative DVT patients in PH group, 4 cases had problems in the left heart function, three of them suffered from aortic valve insufficiency and one suffered from mitral insufficiency. Orthopedic surgeons should pay particular attention to such patients with PH in the perioperative stage to prevent the occurrence of DVT. In addition, the average age of the 238 patients in this study was relatively high, and the operation procedures were difficult to perform. So preoperative echocardiography could not only assess general heart function but also enable the physician to know the patient's PAP value. Therefore, we believe that echocardiography should be considered as one of the routine tests of preoperative examination.

Currently, the literature reports that postoperative DVT mostly occurs in the vena cava. However, among the 18 postoperative DVT patients, the thrombus appeared in the venous plexus of calf muscles in 4 patients, with 2 patients in each group. There are fewer venous valves in the venous plexus of calf muscles, slow blood flow, absence of hard tissues as deep fascia, and vulnerability of the lumen to dilation, which makes it a likely area of thrombosis. Thrombus in the plexus of calf muscles accounts for 40% of peripheral deep venous thrombosis in the lower extremities. 20% of undiscovered thrombus in the plexus of calf muscles develops towards the proximal end in the following two weeks¹⁶. Among those who

died of unknown causes within two weeks after hip and knee replacement, most died from pulmonary embolism caused by shedding of emboli of DVT in lower extremities^{17,18}. Therefore, for PH patients with thrombosis in the plexus of calf muscles, surgeons should review the ultrasound test and reinforce follow-up anticoagulation therapy to avoid the development to real DVT or even fatal pulmonary embolism (PE) after discharge from hospital.

CONCLUSION

PH is a high-risk factor for DVT in the lower extremities post-joint replacement. The pre-existing slow blood flow in the vein and highly coagulative state of patients with PH are risk factors of thrombosis and likely to persist for a long time after the operation. Patients with PH should be informed of thrombosis prevention after discharge from hospital in order to reduce DVT and mortality rate.

Financial Disclosure

No financial disclosure was declared.

Conflict of Interest

No conflict of interest was declared.

Authors Contributions

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RESUMO

OBJETIVO: A hipertensão pulmonar (HP) indica elevação progressiva da resistência vascular pulmonar, levando ao excesso de enchimento, elevação da pressão venosa, congestão em vários órgãos e edema no sistema venoso. Este estudo teve como objetivo investigar se a HP é um fator de risco para trombose venosa profunda (TVP) das extremidades inferiores após cirurgia de prótese de quadril e joelho.

MÉTODOS: Um total de 238 pacientes que receberam a substituição da articulação das extremidades inferiores em nosso departamento de ortopedia de janeiro de 2009 a junho de 2012 foi examinado por ecocardiograma e fluxo de imagem Doppler colorido (CDFI) dos membros inferiores. De acordo com a pressão arterial pulmonar (PAP), os pacientes foram divididos em grupo PAP normal (n=214) e grupo PH (n=24). Todos os pacientes foram reexaminados por CDFI durante os cuidados pós-operatórios.

RESULTADOS: Entre os 238 pacientes, 18 pacientes tiveram TVP nas extremidades inferiores após a operação. A taxa de incidência total de TVP foi de 7,56% (18/238). No grupo PH, 11 pacientes tiveram TVP (45,83%, 11/24), mas no grupo PAP normal, apenas sete pacientes tiveram TVP (3,27%, 7/214). A incidência de TVP foi significativamente menor no grupo PAP normal do que no grupo PH (P<0,01). Além disso, houve uma correlação positiva entre a PAP e a incidência de TVP.

CONCLUSÃO: A HP poderia ser um fator de alto risco para a ocorrência de TVP nas extremidades inferiores do paciente após cirurgias de substituição articular.

PALAVRAS-CHAVE: Hipertensão pulmonar. Artroplastia de substituição. Trombose venosa. Fatores de risco.

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