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Incidence and Clinical Significance of Deep Vein Thrombosis after Cementless Total Hip Replacement in Korean Patient Population

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We studied the incidence of deep vein thrombosis in the 110 Korean patients who had Porous Coated Anatomic (P.C.A.) cementless total hip replacement. The diagnosis of deep vein thrombosis was made by roentgenographic venography. The perfusion lung-scanning was done to make a diagnosis of pulmonary embolism. Our findings showed that there was an unusually low incidence (7 per cent) of deep vein thrombosis in our unprotected patient group. They also revealed that some factors that are believed to be relevant to thrombosis were conspicuously rare in this series. In view of this fact, we re-evaluated the so-called risk factors and came to a conclusion that some of them-such as advanced age, venous valve number, coagulation assay data, orthopedic diagnosis, preoperative limitation of mobility, hypertension, and blood group-that have been claimed to be relevant in fact seem to be irrelevant to deep vein thrombosis.

Key Words: Incidence, deep vein thrombosis, cementless total hip replacement.

In the population of the West, there have been reported high incidence of deep vein thrombosis (35 to 60 per cent in unprotected patients who had an elective hip surgery), pulmonary embolism (2 to 16 per cent), and fatal pulmonary embolism (2 to 3.4 per cent) (Coventry *et al.* 1973; Evarts and Feil 1971; Hampson *et al.* 1974; Harris *et al.* 1977; Morris *et al.* 1974; Rothermel *et al.* 1973; Salzman *et al.* 1971; Schondorf and Hey 1976). Among Orientals, however, it has been said, anecdotally, that there is a considerably lower incidence of deep vein thrombosis. To our best knowledge, no information in this regard is available in English literature.

There has been an overall agreement that predisposing factors to deep vein thrombosis are; advanced age; previous venous insufficiency in the extremities; congestive heart failure or heart disease, or both; prolonged immobilization; malignant disease; obesity; estrogen therapy; and genetic factor (Nicolaides and Irving 1975). Recently, Liu *et al.* (1986) demonstrated that limbs with multiple superficial femoral veins and with more than 5 valves between the level of the popliteal fossa and ischial spine are much higher risk cases for deep vein thrombosis.

Our study was undertaken (1) to document the incidence of deep vein thrombosis in Korean patients, and (2) on this basis to re-evaluate the commonly held views regarding the contributing factors to deep vein thrombosis.

MATERIALS AND METHODS

We obtained informed consent from 125 of 161 consecutive patients who were more than fifty years old and who had cementless P.C.A. (Howmedica, Inc.; Rutherford, NJ) total hip replacement arthroplasty at the Severance Hospital, Yonsei University Medical Center in Seoul, Korea. Of these, 110 patients were included in the study. Fifteen patients who were originally included in the study did not complete it and were subsequently excluded; thirteen of these changed their minds about being included in the study and in the other two we were unable to do a venography. All of the patients were requested to discontinue all aspirin or aspirin-containing compounds as well as any other antiplatelet medication fourteen days before admission to the hospital for the operation.

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The composite characteristics of the patient population were as follows; The right hip was operated on fifty-seven times, and the left one, fifty-three. The patients in the study included 65 women and 45 men, whose ages ranged from fifty to eighty-eight years (mean age, sixty-two years). The distribution by age of the patients: 45 patients were fifty to fifty-nine years old, 28 were sixty to sixty-nine years old, 25 were seventy to seventy-nine years old, and 12 were eighty to eighty-nine years old. The diseases under treatment were: avascular necrosis (30 patients), osteoarthritis (30 patients), neglected femoral neck fracture (22 patients), degenerative arthritis secondary to trauma (4 patients), quiescent tuberculous arthritis (3 patients), childhood pyogenic arthritis (2 patients), congenital dysplasia of the hip (1 patient), and ankylosing spondylitis (1 patient). Fifteen patients were treated for a failed total hip replacement and two were treated for a failed endoprosthesis. All patients were followed for at least six months after the arthroplasty.

The surgery was performed under general anesthesia, using the modified Gibson approach in 66 patients and Moore approach in 44 patients. The surgery was carried out by one surgeon (Young-Hoo Kim) using P.C.A. prosthesis in all patients. No patient wore elastic stockings or elastic wraps preoperatively and during the operation. Postoperatively, six patients had elastic stockings on throughout the hospital course due to swelling of the lower extremities. Two hemovac drains (one superficial and one deep) were placed in the wound; they were removed after twenty-four hours. The patients were placed in the balanced splint until the second postoperative day, when standing was allowed. Walking with crutches was permitted shortly thereafter. No patient received prophylactic agents for deep vein thrombosis.

A clinical diagnosis of deep vein thrombosis was made if a patient had tenderness in the calf; edema of the calf, or foot; persistent venous distension in the foot; or a positive Homan's sign. No patient had a history of prior deep vein thrombosis or presence of varicose veins.

Pulmonary embolism was diagnosed if a patient had pleuritic chest pain, dyspnea or discomfort in the chest associated with a fall in Po_2, or hemoptysis or a friction rub.

Coagulation assays, complete blood count, and blood typing were carried out and chemical values were checked out in all patients. Blood samples were drawn one day prior to the surgery, on postoperative 2 or 3, and on postoperative day 7 or 8.

The confirmed diagnosis of deep vein thrombosis was made only by venography for the following specific reasons: By this method, (1) The whole of the venous system from calf to vena cava can be visualized. (2) Not only can the site of thrombi but also size and nature of them can be accurately determined. Only by this method can one determine whether a thrombus is loose or adherent. (3) Visualization of the femoral and ilio-femoral segments, arguably the most important segments, cannot be accurately done by any other means. Radioactive ^{125}I fibrinogen has the disadvantages of inaccuracy in the ilio-femoral segment and the results are invalid in the presence of a large healing wound, which is present in this type of surgery.

Roentgenographic venography was performed, using the technique of Rabinov and Paulin (1972). In conjunction with the Department of Radiology, we have developed an investigational protocol of performing preoperative and 10-11 day postoperative operated leg venography. The roentgenographic abnormalities were categorized as: (1) filling defect; (2) non-filling of segments; (3) abrupt termination of veins; or (4) abnormal venous patterns, meaning tortuous vessels or collateral channels (Rabinov and Paulin 1972). Also, variations of the superficial femoral vein and popliteal vein anatomy were studied. The number of the valves of the deep veins from the level of the popliteal fossa up to the ischial spine region were also tabulated. Statistical analysis was obtained by using the chi-square test with Yates' correction, in order to determine the significance of the variations of vein numbers and the differences in the number of valves in the superficial femoral vein. The correlations between the patients with a total hip replacement and the incidence of deep vein thrombosis were analyzed with respect to these two factors.

The perfusion lung-scanning was done in all patients by a standardized technique preoperatively and 9 to 10 days after the arthroplasty.

At operation, all sponges were weighed, the volume of aspirated blood was measured, and the blood loss on the surgical drapes was estimated. The postoperative blood loss in the suction drainage was measured and recorded. The amount of blood and blood products or blood substitutes used for the replacement intraoperatively and postoperatively was recorded.

RESULTS

Eight of the 110 patients (7 per cent) had fresh

thrombi. All of the thrombi occurred in the lower limb that was operated on and all of these thrombi were silent. Only six of the 110 patients in the study had clinical manifestations suggesting deep vein thrombosis. These patients presented with edema of the calf or ankle, but in all of these patients the venography was negative. The average age of the eight patients (four men and four women) with thrombi was sixty years (range, fifty to seventy-four), while that of the patients without thrombi was sixty-one (range, fifty to eighty-eight). The distribution by age of the patients with thrombi was: 5 were fifty to fifty-nine years old, 2 were sixty to sixty-nine years old, and 1 was seventy to seventy-nine years old. The incidence of thrombosis in men was four in 45 patients (9 per cent) and in women it was four in 65 patients (6 per cent).

One patient had thrombi in the femoral vein; two, in the femoral and popliteal veins; two, in the femoral, politeal and calf vein; one, in the femoral and calf vein; and two, in the calf veins. None of these patients were treated to study the natural history of deep vein thrombosis but no patient had a recurrence of thrombosis.

Of 110 examinations performed, we found all satisfactory for evaluating anatomic variations, and 72 limbs detailed sufficently to assess the number of valves present. There were single superficial femoral vein in 53 limbs; accessory femoral vein in 26 limbs; duplication of superficial femoral vein and popliteal vein in 3 limbs; duplication of popliteal vein in 18 limbs; duplication of popliteal vein and multiple accessory superficial femoral vein in 3 limbs; multiple accessory popliteal vein in 1 limb; and multiple accessory superficial femoral vein and multiple popliteal vein in 6 limbs. For the purposes of statistical analysis, both the superficial femoral vein and popliteal vein were divided into single and multiple groups. There were multiple superficial femoral veins in 35 (32 per cent) of the total limbs we examined. Of the limbs with multiple superficial femoral veins, 6 (17 per cent) had deep vein thrombosis. This was a statistically higher incidence ($p<0.001$) than that seen in the 2 (3 per cent) of 75 limbs with a single superficial femoral vein based on Chi-square test (Table 1). There were multiple popliteal veins in 19 (17 per cent) of the total limbs. Of the limbs with multiple popliteal veins, 1 (5 per cent) had thrombi. Of the 91 limbs with single popliteal veins, 7 (8 per cent) had thrombi. We found no statistical relationship ($p>0.05$) relevant to the incidence of deep vein thrombosis between single and multiple popliteal veins (Table 2). Twenty-eight of the 32 limbs (88 per cent) without thrombi had more than

Table 1. Relation of DVT* between single and multiple SFV**

	Single SFV	Multiple SFV	Total
DVT (+)	2 (3%)	6 (17%)	8 (7%)
DVT (−)	73	29	102
Subtotal	75	35	110

P<0.001

* DVT: Deep Vein Thrombosis

**SFV : Superficial Femoral Vein

Table 2. Relation of DVT* between single PV and multiple PV**

	Single PV	Multiple PV	Total
DVT (+)	7 (8%)	1 (5%)	8 (7%)
DVT (−)	84	18	102
Subtotal	91	19	110

p>0.05

* DVT: Deep Vein Thrombosis

**PV : Popliteal Vein

Table 3. Relation between DVT and Valve number

	Valve number		
	⩽5	>5	Total
DVT (+)	4 (10%)	4 (13%)	8
DVT (−)	36	28	64
Subtotal	40	32	72

P>0.05

5 valves, whereas only 4 of the 32 limbs (13 per cent) with thrombi had more than 5 valves. Thirty-six of the 40 limbs (90 per cent) without thrombi had less than 5 valves, whereas only 4 of the 40 limbs (10 per cent) with thrombi had less than 5 valves. We found no significant relationship between the incidence of deep vein thrombosis and the number of valves ($p>0.05$) (Table 3.)

Comparison of the coagulation assay data of the two groups, one with normal and the other with abnormal venographies is presented in Table 4. There were no significant differences in coagulation assay data pre-and post-operatively between those two groups. The distribution by blood group of the patients with thrombosis was: four patients were group 0 (out of the total 43 patients with group 0), two were

Table 4. Results of Coagulation Assays in Patient Groups with Normal and Abnormal Venographies

Venography group	Platelet count			P.T.			P.T.T.			Fibrinogen		
	1	2	3	1	2	3	1	2	3	1	2	3
Normal	146,000–617,000 (306,200± 83,600)	137,000–786,000 (409,500± 131,000)	279,000–613,000 (437,000± 111,000)	9.7–16.6 (11.1± 1.1)	9.6–12.6 (10.9± 0.7)	9.8–12.3 (10.8± 0.7)	22.8–55.2 (36.7± 8.5)	22.0–63.4 (34.1± 8.2)	23.0–46.2 (31.7± 6.2)	141–560 (311 +91)	280–800 (484 ±120)	200–850 (465 ±133)
Abnormal	154,000–597,000 (355,000± 108,200)	148,000–677,000 (395,000± 121,000)	258,000±674,000 (408,000± 123,800)	9.6–12.3 (10.9± 0.8)	9.6–12.8 (10.8± 0.6)	9.9–13.3 (10.6± 0.7)	22.0–50.6 (32.8± 7.1)	22.8–65.6 (34.3± 8.4)	24.0–47.4 (31.9± 6.5)	169–850 (375 ±157)	240–810 (478 ±130)	210–820 (475 ±143)
P-value	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Venography group	Factor III			Factor VIII			Anti-thrombin III		
	1	2	3	1	2	3	1	2	3
Normal	6.1–16.3 (10.0± 2.4)	6.5–16.3 (10.4± 2.4)	5.0–13.8 (9.7± 2.2)	55–180 (109.6 ±23.4)	60–240 (133.2 ±36.2)	74–150 (111.4 ±21.9)	85–115 (104 ±8.1)	87–100 (84.6 ±7.8)	91–117 (97.4 ±6.8)
Abnormal	7.5–18.1 (11.2± 3.4)	6.7–17.4 (10.6± 3.4)	5.8–13.6 (10.7± 2.4)	72–140 (115.8 ±24.0)	62–250 (124.4 ±38.2)	75–160 (114.6 ±32.8)	87–118 (106.0 ±7.2)	84–102 (81.6 ±4.6)	85–118 (95.6 ±7.6)
P-value	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

1: Preoperative. 2: Postoperative Day 2-3. 3: Postoperative Day 7-8. N.S.: Not Significant

group A (out of 29 with group A), one were group B (out of 23 with group B), and one was group AB (out of 15 total).

The average time of the anesthesia was 223 minutes (range, 135 to 525 minutes) and the average operating time was 184 minutes (range, 100 to 460 minutes). These were nearly the same for the two groups. Blood loss, as judged from intraoperative measurement (average, 805 millimeters) and the amounts of suction drainage (average, 801 millimeters), was nearly the same in the two groups. There was no difference in the preoperative hematocrits of the patients in the two groups, nor was there any difference in their postoperative hematocrits on the day of the surgery, on the first postoperative day, or on the following day. Also, no difference was seen in their preoperative cholesterol, triglyceride, total protein and calcium levels.

Our analysis of the incidence of deep vein thrombosis with regard to sex, orthopedic diagnosis, surgical approach, and the presence of hypertension revealed no significant differences between the two groups.

The average time lengths until the patient sat on the edge of the bed (one day), walked for the first time (three days), and was discharged from the hospital (fourteen days) were the same in the two groups.

No pulmonary emboli occurred in our series. Three patients died, one 8 months and two 13 months after the operation, all from unrelated causes. Three patients had skin necrosis as local complication and one patient had allergic reaction to the contrast madia used for venography.

DISCUSSION

Our study of the 110 Korean patients revealed a strikingly low incidence of deep vein thrombosis (8 patients, or 7 per cent) in this patient group. It also has shown us that some of the factors that are widely believed to contribute to deep vein thrombosis, in fact, do not seem to have any correlation with deep vein thrombosis while other factors seem to have

more immediate relevancy. The factors that do not seem to have much relevancy to deep vein thrombosis are: age, venous valve number, coagulation assay data, orthopedic diagnosis, preoperative limitation of mobility, hypertension, and blood group.

It has been claimed that the incidence of deep vein thrombosis and pulmonary embolism increases after forty years of age (Nillus and Nylander 1979; Salzman and Harris 1976; Sikorski *et al.* 1981). Our study, however, which was confined to patients whose ages were over 50 (thirty-four per cent was more than 70 years old) revealed that advanced age was not necessarily a risk factor.

Liu *et al.* (1986) had suggested that limbs with multiple superficial femoral veins and with more than 5 valves are high risk for deep vein thrombosis, and, on these bases, they claimed that venous stasis may predispose the limb to thrombosis. We noticed in our study that limbs with multiple superficial femoral vein had higher incidences of thrombosis than limbs with single superficial femoral vein. However, on the other hand, we found no significant difference in predilection for thrombosis between the patients who had more than 5 valves and those whe had less than that. Furthermore, the majority of the patients with multiple superficial femoral vein and the majority of the operated legs in our group did not have thrombi. These facts lead us to believe that there is little correlation between the venous stasis and the development of thrombosis.

Stulberg *et al.* (1984) suggested a possible relationship between anti-thrombin III activity and the occurrence of significant deep vein thrombosis; in their prospective evaluation of anti-thrombin III activity, they observed abnormal depression of activity in all patients with documented venous thrombosis. Gallus *et al.* (1981), however, found no major persistent differences in 14 tests of coagulation, using the ^{125}I fibrinogen scan as an indicator of deep vein thrombosis, before and after a major surgery. Our coagulation assay data supports Gallus *et al.*. They were all normal pre-and post-operatively and showed no correlation between the coagulation factors and the development of thrombosis.

Sikorski *et al.* (1981) reported that there is higher incidence of deep vein thrombosis in the patients with osteoarthritis. In our study, the distribution by disease of the patients with thrombosis were: three osteoarthritis patients (out of the total 30 patients with osteoarthritis); another three had avascular necrosis patients (out of 30 with avascular necrosis): and two patients with neglected femoral neck fracture (out of 22 total). Hence our data do not support the view that osteorathritis is particularly a risk factor.

In our series, we had anticipated that the patients with neglected femoral neck fracture would have higher incidence of thrombosis since they had been bed-ridden or confined to wheel-chairs for about 3 months before the operation. But it turned out that only two of the 22 patients had deep vein thrombosis. This seems to suggest that preoperative limitation of mobility is not necessarily a risk factor.

Evarts and Feil (1971) reported that patients with hypertension have higher incidence of deep vein thrombosis. Yet, in our series, not a single patient out of the total thirty-five who required treatment for hypertension had thrombosis. Therefore, again, we are led to suspect that hypertension probably is not a contributing factor.

Patients with blood group 0 are claimed to have low incidence of deep vein thrombosis (Jick *et al.* 1969; Salvati and Lachiewicz 1976). In our series, of the eight with thrombosis, four were of the group 0; two of the group A; one of the group B; and one of the group AB. This data reveals that blood group 0 is not necessarily immune to deep vein thrombosis.

It had been reported that surgical approach influnces the incidence of deep vein thrombosis (Lowe *et al.* 1978; Sikorski *et al.* 1981). The classical lateral approach to the hip joint, involving a trochanteric osteotomy, had been associated with a significantly higher risk than the posterior approach. They claimed that this is probably a positional effect rather than a direct result of the osteotomy since anterolateral approach, which does not include osteotomy, carries the same high risk. We found no differences in predilection to thrombosis in relation to the surgical approach.

On the other hand, our analysis of the low incidence of deep vein thrombosis in our Korean patients group seems to suggest the relevancy of certain other factors.

Obesity is believed to increase the incidence of deep vein thrombosis (Atik *et al.* 1970). Our study supports this view. We had three obese patients who weighed over 80Kg. and they were all female. The average weight of our patients were: male, 60.5Kg., and female, 51.7Kg. All of our three obese patients had deep vein thrombosis.

It has been believed that prolonged immobilization postoperatively increases the incidence of deep vein thrombosis and that the venous return from the lower limbs can be accelerated by early mobilization of the patient after the operation (Sevitt and Gallagher

1959; Sikorski *et al.* 1981; Wright *et al.* 1951). In our series, we had allowed our patients to ambulate early (average, 3 days) after the operation, and this factor might have contributed to the low incidence of the deep vein thrombosis.

As has been reported by other authors (Nillus and Nylander 1979; Sikorski *et al.* 1981), we found no definite relationship between severity of operation and development of deep vein thrombosis. Neither duration of operation, nor operative blood loss, nor the amount of blood transfused seem to have affected the incidence of deep vein thrombosis.

There has been a view that varicose vein might be a contributing factor to deep vein thrombosis. No one in our 8 patients with thrombosis had varicose vein. (Varicose vein is rare in Korean population).

There has been some controversy over the effect of heat generated acrylic cement in the formation of deep vein thrombosis. Johnson *et al.* (1978) argued against it; while Engh (1983) reported that there was 1 per cent of deep vein thrombosis and 2 per cent of pulmonary embolism in his patient group who had a cementless total hip replacement. We did not use bone cement in our patients and this fact might or might not have played a part in the low incidence of deep vein thrombosis. This remains to be further clarified in future studies.

It has been recognized that hyperlipemia may not only accelerate blood clotting but may also increase blood viscosity and adhesiveness as well as aggregation of the red blood cells. Our study seems to support this view; all our 110 patients were free of hyperlipemia and, in fact, there is considerably lower degree of hyperlipemia in Korean population on the whole.

As has been amply demonstrated by many investigsators (Dorr *et al.* 1979; Evarts and Alfidi 1973; Evarts and Feil 1971; Harris *et al.* 1977; Salzman and Harris 1976; Simon *et al.* 1982) clinical evaluation for the presence of deep vein thrombosis have proved inaccurate. Six of our patients had clinical evidence of thrombosis, although venographies were negative and of the eight patients who did not have clinical evidence of thrombosis, all had venographic evidence.

In conclusion, the factors that do not seem to have much relevancy to deep vein thrombosis are: age, venous valve number, coagulation assay data, orthopedic diagnosis, preoperative limitation of mobility, hypertension, and blood group. On the other hand, the relevant factors are: obesity, postoperative prolonged immobilization, varicose vein, using heat generated bone cement, and hyperlipemia.

In view of the various facts noted above in result of our comparative study regarding contributing factors to deep vein thrombosis, further extensive studies of Oriental patient population seem to be desirable, whose genetic as well as environmental constitution offer a valuable point of comparison.

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