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# Strenuous sport activities involving the upper extremities increase the risk of venous thrombosis of the arm

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Upper extremity venous thrombosis comprises about 4% of all venous thrombosis [1]. Central venous catheters are the most common cause, while other risk factors for venous thrombosis of the arm are similar to those of the leg, for example, malignancies and surgery (J. W. Blom, personal communication). Upper extremity thrombosis also occurs as the Paget-Schrötter syndrome, which results from overdevelopment of the anterior scalene muscle because of vigorous exercise [1]. This is often referred to as effort-related thrombosis and several case reports have been published of athletes developing arm thrombosis after strenuous arm activities [2]. However, there are no risk estimates from controlled studies. In the present population-based case-control study, we evaluated the risk of developing an upper extremity venous thrombosis after regular sport activities. To determine whether it was indeed a local effect, a distinction was made between sports involving mainly one arm-like tennis and those involving two arms-like swimming.

Consecutive patients with a first venous thrombosis of the arm aged 18–70 years were included from March 1999 to the end of September 2003 in a large population-based case-control study, the Multiple Environmental and Genetic Assessment of risk factors for venous thrombosis study (MEGA study), which has been described previously [3]. In the earlier report, we showed risk estimates for upper extremity venous thrombosis, mainly focusing on central venous catheters and malignancies, which were excluded here. Overall, the response of patients with venous thrombosis of the arm was 99% (J. W. Blom, personal communication). In all those patients of whom a letter on applied diagnostic methods could be obtained (70%), the diagnosis was objectively confirmed by ultrasound, contrast venography or computed tomography. Control subjects were recruited from the general population within the same geographical area by using a random digit dialing method from January 2002 to the end of October 2003 [4]. The control subjects were frequency-matched on sex and age with patients, and 65.8% of the eligible contacted individuals participated.

All participating control subjects received a standardized questionnaire within a few weeks after the moment of inclusion and participating cases within a few weeks after their index date. The index date was defined as the date of venous thrombosis for the patients and as the date of filling in the questionnaire for the control subjects. All participants gave a written informed consent. This study was approved by the Ethics Committee of the Leiden University Medical Center. Body mass index (BMI) was calculated from self-reported weight (kg) divided by height (m) squared as  $\text{kg m}^{-2}$ .

Information on sport activities in the 12 months prior to index date was available for all 110 patients and for 1106 (94.7%) of the participating control subjects. To enlarge the contrast between athletes and inactive individuals, we only included participants who indicated to take part in sport at least once a week, and those who indicated not to engage in sport at all. Hence, those with an unknown sport frequency (zero patients and seven control subjects) or with a frequency of less than once a week (nine patients and 121 control subjects) were excluded. Therefore, 101 patients and 978 random control subjects remained for the present analyses. Sports were divided into categories: badminton, baseball, handball, squash, tennis, volleyball, and waterpolo were considered as strenuous sport activities involving one upper extremity or as single arm-sports, while (acrobatic) climbing, bodybuilding, canoeing, fitness, judo, push-ups, rowing, swimming, and wrestling were considered as double arm-sports. All remaining sport activities were categorized as 'other sports', and included, among others, running, soccer, and cycle-racing.

Analyses were performed for overall thrombotic risk, and for the risk of an idiopathic thrombosis. A total of 68 patients and 834 control subjects were considered to be at risk for idiopathic thrombosis, as they did not have a surgery, plaster cast, minor injury, or pregnancy and were not immobilized for at least 14 days in the month prior to their index date.

Odds ratios (OR) were calculated as estimates of the relative risk with 95% confidence intervals (CI) constructed according to Woolf [5]. By using multiple logistic regression OR were adjusted for age, sex, and BMI (OR<sub>adj</sub>).

Median age of the 101 patients was 39.7 (5–95th percentile: 20.6–64.2) years, while it was 42.9 (5–95th percentile: 20.8–66.5) years for the 978 control subjects. There were 53 women (52.5%) in the patient group and 524 (53.6%) in the control group. Median BMI of both groups was similar; 24.5 (5–95th

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**Table 1** Risk of developing an idiopathic upper extremity venous thrombosis in the presence of sport activities

Total	Control subjects	Patients total	OR* (95% CI)	Patients left arm	OR* (95% CI)	Patients right arm	OR* (95% CI)
No sports	453	37	1.00	23	1.00	14	1.00
Arm-sports	257	24	1.08 (0.63–1.87)	8	0.54 (0.24–1.25)	16	2.04 (0.97–4.33)
Single arm-sports	99	9	1.07 (0.50–2.31)	2	0.37 (0.09–1.62)	7	2.27 (0.88–5.81)
Double arm-sports	158	15	1.09 (0.57–2.07)	6	0.64 (0.28–1.65)	9	1.89 (0.79–4.57)
Other sports	124	7	0.61 (0.26–1.41)	5	0.65 (0.24–1.77)	2	0.50 (0.11–2.26)

\*Adjusted for age, sex, and BMI.

BMI, body mass index; OR, odds ratio; CI, confidence interval.

percentile: 18.3–33.4) kg m<sup>-2</sup> for the patients and 24.4 (5–95th percentile: 19.5–32.5) kg m<sup>-2</sup> for the control subjects.

A total of 45 patients (43.7%) were active in sports compared with 453 (44.9%) control individuals. Overall, athletes had no evidently different risk of developing an upper extremity venous thrombosis than those who did not engage in sports (OR<sub>adj</sub> 0.86; 95% CI: 0.57–1.31). No difference was found for those who performed any kind of arm-sports, compared with those not participating in sports (OR<sub>adj</sub> 1.03; 95% CI: 0.65–1.62). Analysis restricted to idiopathic thrombosis yielded the same result (OR<sub>adj</sub> 1.08, 95% CI: 0.63–1.87). Participation in 'other sports' (sports not involving the arms) appeared to decrease the risk of venous thrombosis of the arm (OR<sub>adj</sub> 0.56; 95% CI: 0.27–1.16) compared with those not involved in any sports. The analysis restricted to idiopathic thrombosis suggested the same result, i.e. a reduced risk of arm thrombosis associated with involvement in sports not specifically involving the arms (OR<sub>adj</sub> 0.61; 95% CI: 0.26–1.41; Table 1). Compared with those performing other sports, arm-sports slightly increased the risk of venous thrombosis of the arm (OR<sub>adj</sub> 1.79, 95% CI: 0.75–4.29).

We found a difference in risk of developing an idiopathic venous thrombosis in the right and left arm. In non-athletes (left arm: 23 of 37 patients, 62%) and in those performing other sports (left arm: five of seven patients, 71%) venous thrombosis occurred slightly more frequently in the left arm compared with the right arm. However, for those involved in arm-sports, most events occurred in the right arm (left arm: eight of 24 patients, 33%). Only two of nine patients (22%) who participated in a single arm-sport had their venous thrombosis located in their left arm. This was six of fifteen (40%) for those participating in double arm-sports. The risk of a venous thrombosis in the right arm was more than twofold higher for those participating in arm-sports compared with those who did not sport at all (OR 2.04; 95% CI: 0.97–4.33). When split into single and double arm-sports the adjusted OR was 2.27 (95% CI: 0.88–5.81) for those participating in single arm-sports, while it was 1.89 (95% CI: 0.79–4.57) for those participating in double arm-sports. For the left arm the risk of venous thrombosis was similar for those performing single arm-sports (OR<sub>adj</sub> 0.37; 95% CI: 0.09–1.62), double arm-sports (OR<sub>adj</sub> 0.64; 95% CI: 0.25–1.65), and other sports (OR<sub>adj</sub> 0.65; 95% CI: 0.24–1.77), compared with non-athletes (Table 1).

Sport activities not strenuously involving the arm may decrease the risk of upper extremity venous thrombosis.

However, sports activities that involve strenuous arm exercise increase the risk of thrombosis in the right arm twofold, with the most evident effect for single-arm sports. This arm is most likely to be the right arm because this will be the dominant arm in most athletes, unfortunately we had no information of left or right dominance. In non-athletes and in those performing other sports venous thrombosis occurred slightly more often in the left arm. This might be due to anatomic differences because the brachiocephalic vein is located more horizontally on the left side [6].

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