Enhanced oxidative stress in workers with a standing occupation

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Background: Several epidemiological studies have shown a statistically significant association between standing work and chronic venous insufficiency of lower limbs. This condition has been associated with an enhanced oxidative stress that, according to the literature, could represent a risk factor for cardiovascular and other systemic diseases.

Aims and Methods: To evaluate venous pressure of the lower limbs and reactive oxygen species (ROS) before and after work in 62 workers with a standing occupation (surgery room nurses) and 65 outpatient department nurses who can walk during their working time.

Results: After work, a statistically significant increase of venous pressure of the lower limbs levels was observed in both the study group and controls. Standing workers showed significantly higher mean levels of ROS after work.

METHODS

We consecutively examined 98 surgery room workers (group 1), who stand at the surgical table without walking for more than six hours during their shift (up to 3.5 hours standing during their shift (up to about 50% of the working time), and 65 outpatient department nurses as the control group (group 2), who spend up to 3.5 hours standing during their shift (up to about 50% of the working time). Subjects gave their written informed consent and the study was approved by the Catholic University Committees.

Group 1 was composed of 62 females (mean age 45.32 (6.70) years, BMI 24.46 (3.12) kg/m²); group 2 was composed of 65 females (mean age 45.65 (8.47) years, BMI 25.44 (3.99) kg/m²).

Subjects were recommended not to wear any compression socks or stockings during their work that day. All workers were examined in a constant temperature room (20°C) before and after work and underwent the following:

- Venous pressure measurement of the lower limbs: while the subject was standing we applied a sphygmomanometer tourniquet at the calf and measured the pressure at the long saphenous vein root with a Doppler 8 MHz probe in each limb according to a standardised method.
- Blood collection from the antecubital vein, using a 21 gauge syringe.

Measurement of reactive oxygen metabolites

Blood was centrifuged at 3000 rpm (0.65 g) for 10 minutes; serum was separated and analysed for the presence of ROS with the dROMs test (DIACRON, GR, Italy). Briefly, for each patient, 5 μl of serum or standard were added to a solution containing 1 ml of acetate buffer (pH 4.8) and 10 μl of chromogen. After incubation at 37°C for 75 minutes, samples were analysed by spectrophotometry (Beckman...
Oxidative stress and standing occupations

Main messages

- On average, healthy workers with a standing occupation show an enhanced production of reactive oxygen species in the systemic circulation in comparison with ambulatory workers from the same profession.
- After work, the oxidative stress threshold is exceeded in most standing workers.

Table 1 Mean (SD) with 95% CI of venous pressure (VP) in both limbs and reactive oxygen metabolites (ROS) before and after work in the two groups; the mean percentage changes between pre-work and after-work level in the two groups are also shown.

<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
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<th>Group 2</th>
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<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>95% CI</td>
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<td>VP before (mm Hg)</td>
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<td>Left</td>
<td>55.64 (19.97)</td>
<td>50.57 to 60.71</td>
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<td>56.33 (16.70)</td>
<td>52.16 to 60.50</td>
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<td>Right</td>
<td>56.05 (21.64)</td>
<td>50.55 to 61.54</td>
<td>Right</td>
<td>56.23 (18.14)</td>
<td>51.74 to 60.72</td>
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<tr>
<td>VP after (mm Hg)</td>
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<tr>
<td>Left</td>
<td>83.39 (17.57)</td>
<td>78.92 to 87.85</td>
<td>Left</td>
<td>75.39 (16.70)</td>
<td>71.15 to 79.63</td>
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<td>Right</td>
<td>84.60 (17.54)</td>
<td>80.14 to 89.05</td>
<td>Right</td>
<td>76.54 (17.30)</td>
<td>72.25 to 80.82</td>
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<td>P (before v after)</td>
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<td>Left</td>
<td>&lt;0.0001</td>
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<td>VP Δ%</td>
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<td>Left</td>
<td>70.28 (79.22)</td>
<td>50.16 to 90.40</td>
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<td>40.95 (40.21)</td>
<td>30.90 to 50.99</td>
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<td>Right</td>
<td>77.06 (95.67)</td>
<td>52.77 to 101.36</td>
<td>Right</td>
<td>45.71 (34.08)</td>
<td>34.08 to 57.33</td>
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<tr>
<td>ROS (U) before</td>
<td>283.10 (69.82)</td>
<td>266.30 to 301.73</td>
<td>Left</td>
<td>253.94 (66.70)</td>
<td>246.25 to 277.78</td>
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<tr>
<td>ROS (U) after</td>
<td>338.51 (69.82)</td>
<td>315.60 to 357.88</td>
<td>Right</td>
<td>263.09 (63.53)</td>
<td>236.09 to 269.50</td>
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<tr>
<td>P (before v after)</td>
<td>0.36 to 18.56</td>
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<td>14.47 to 27.34</td>
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<tr>
<td>ROS Δ%</td>
<td>20.90 (25.33)</td>
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<td>9.10 (38.17)</td>
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Policy implications

- Detection of workers at risk for oxidative stress is possible by measurement of reactive oxygen species before and after work.
- Healthy workers could also be at risk for enhanced oxidative stress because of a standing profession.
- Further research is needed to evaluate whether common prevention measures (such as compression stockings, rest breaks, mini breaks, chances for ambulation while working) are able to correct the oxidative stress related to standing occupations.
Among the mediators of vessel wall damage, ROS play an important role, acting through two main mechanisms. The first is the oxidation of cell membrane components, followed by endothelium damage, which eventually leads to increased vascular permeability. The second mechanism is the chemotaxis and activation of leukocytes and platelets. As these mechanisms work together, cell damage is amplified and venous stasis is increased.

According to our previous findings, after venous stasis induced by 60 minutes of upright position, ROS production is significantly higher in patients with varicose veins than controls, and this alteration can be corrected by long saphenous vein stripping. In the present study we observed the phenomenon. We are currently investigating the prevention of this

Several studies have shown that oxidative stress is an important risk factor for cardiovascular and other systemic diseases. Our data showing an enhanced oxidative stress in standing workers may represent an important step forward in the evaluation of professional risks, although further studies are needed to assess whether ROS production could be a risk factor for systemic diseases. It would be advisable to avoid the hyperproduction of ROS in people with standing professions, by means of suitable preventive measures (compressive stockings and, if possible, rest breaks, mini breaks, or chances for ambulation while working, etc). We are currently investigating the prevention of this phenomenon.

**REFERENCES**