B-mode and colour Doppler ultrasonography of the milk vein in 29 healthy Swiss braunvieh cows

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Abstract

The morphology and diameter of the milk vein of 29 healthy Swiss braunvieh cows and the velocity of blood flow through it was measured by colour Doppler ultrasonography before and 10 minutes after they had been sedated with 0.03 mg/kg xylazine. The milk vein was situated immediately under the skin. It had a diameter of 0.8 to 1.6 cm and valves were visible in the milk vein of 12 of the cows. The spectral display appeared as a broad band structure with a wave-like course. The Doppler measurement point was 0.4 to 0.8 cm from the body surface. The diameter of the vein and the blood flow velocity did not differ significantly before and after the cows were sedated. The mean (sd) diameter of the milk vein before they were sedated was 1.3 (0.3) cm. The mean maximum blood flow velocity before they were sedated was 45.4 (12.5) cm/second, the mean velocity was 33.5 (9.5) cm/second, and the mean minimum was 25.8 (11.6) cm/second. There were significant correlations between the blood flow velocities before and after the cows were sedated and between individual cow's blood flow velocities, with correlation coefficients ranging from 0.69 to 0.94.
B-mode and colour-Doppler sonography of the milk vein in 29 healthy Swiss Braunvieh cows

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Summary

The goal of this study was to determine the morphology and diameter of the milk vein and to measure the blood flow velocity using colour-Doppler sonography in 29 healthy Swiss Braunvieh cows. After clipping the hair, the left milk vein was examined before and 10 minutes after administration of 0.03 mg/kg xylazine. The milk vein appeared as a vessel situated immediately under the skin. It had a diameter of 0.8 to 1.6 cm, and valves were seen in the milk vein of 12 cows. The spectral display appeared as a broad band structure with a wave-like course. The Doppler measurement point was 0.4 to 0.8 cm from the body surface. The diameter of the milk vein and the blood flow velocity did not differ significantly before and after sedation. The mean diameter of the milk vein before sedation was 1.3 ± 0.3 cm. The blood flow velocity before sedation had a maximum of 45.4 ± 12.5 cm/s, a mean of 33.5 ± 9.5 cm/s and a minimum of 25.8 ± 11.6 cm/s. There were significant correlations between blood flow velocity before and after sedation and between individual blood flow velocities with correlation coefficients ranging from 0.69 and 0.94.

Introduction

Careful examination and evaluation of the milk vein in cows is important for a number of reasons. The milk vein is easily accessible and does not require occlusion prior to injection and is therefore commonly used for administration of medications (Stöber 1990); thrombophlebitis and cellulitis are relatively common sequelae (Braun and others 2005) and infection may metastasize to other organs including the heart and lungs leading to valvular disease and suppurative bronchopneumonia (Braun 2002). The milk vein is also predisposed to injury by other cows and environmental hazards because of its superficial location. In patients with right-sided cardiac insufficiency, the milk vein may be dilated. The results of inspection and palpation of the milk vein are subjective and difficult to interpret because its dimensions vary widely among cows. Thrombophlebitis of the milk vein is diagnosed clinically but ultrasonography is required to fully assess the extent and nature of the lesion. Thus, the goal of this study was to
investigate the morphology and diameter of the milk vein and blood flow velocity in healthy cows using B-mode and colour-Doppler sonography to obtain data that could serve as a base for interpretation of diseases of the milk vein. The examinations were done on sedated and non-sedated cows because sedation may affect blood vessel diameter and blood flow velocity. The information thus gained is useful for the veterinarian because sedation is commonly required for the examination of cattle (Braun and Föhn 2005).

Materials and methods

Animals

Twenty-nine healthy Swiss Braunvieh cows ranging in age from 2.5 to 8.0 years (mean, 4.6 years) were used. The cows were clinically healthy, not pregnant and were examined via colour-Doppler sonography between 08:00 and 10:00 while standing in stocks.

B-mode and colour-Doppler sonography

The procedure for B-mode and colour-Doppler sonography has been described in detail elsewhere (Hoegger 2006). The hair over the left milk vein was clipped to yield a 20-cm length for examination. A 5.0 MHz real-time linear transducer (Hitachi Ultrasound scanner EUB 8500) was used to examine the milk vein twice. The first examination was done without sedation and the second was carried out 10 min after intravenous administration of 0.03 mg/kg xylazine (Rompun, Bayer) intravenously. Care was taken not to compress the milk vein during the examination. The vein was first examined in longitudinal and cross section with B mode. The diameter of the milk vein was measured electronically in cross section after storing of the ultrasonographic image by means of the two cursors the from intima to intima of the vessel. Then, the colour-Doppler gate was directed parallel to the wall of the vein to visualise the blood flow and then positioned at a 60° angle in the centre of the milk vein. By turning on the
pulsed-wave colour-Doppler ultrasound instrument, audible sound could be heard and the spectral display was visible on the screen. Optimal colour flow and spectral curve images were frozen on the screen to determine the distance between the Doppler measurement point and the body surface, the diameter of the vein and the maximum, minimum and mean blood flow velocities.

Approval of the study by an ethical committee
The study was approved by an ethical committee of the canton of Zurich, Switzerland.

Statistical analysis
The statistical analyses were done using StatView 5.0 (SAS Institute, 8602 Wangen, Switzerland). The frequencies, means and standard deviations of all measured variables were determined. Differences between measurements were analyzed using an unpaired t-test. The range between the 10th and the 90th percentiles was considered the normal range. Correlations were calculated for measurements obtained before and after sedation and between different flow velocities.

Results
Morphological observations with B-mode sonography
The milk vein could be visualised in all the cows and appeared as a vessel with a diameter of 0.8 to 1.6 cm immediately beneath the skin (Fig 1). The mean diameter of the milk vein was 1.3 [0.3] cm before and after sedation (P > 0.05; Table 1). Valves were seen in the milk veins of 12 cows; they appeared as echogenic, structures, which were 1 to 2 mm in length, projected from the wall of the vein and moved slowly in the blood.
Figure 1: B-mode ultrasonogram of the milk vein showing the valves. 1 Skin, 2 Milk vein, 3 Valve, 4 Abdominal wall, Cr Cranial, Cd caudal

Table 1: Mean and sd of various sonographic variables of the milk vein in 29 healthy cows.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Before sedation (mean [sd])</th>
<th>After sedation (mean [sd])</th>
<th>Range before sedation</th>
<th>Range after sedation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance between the Doppler measurement point and body surface (cm)</td>
<td>0.5 [0.1]</td>
<td>0.5 [0.1]</td>
<td>0.4 – 0.8</td>
<td>0.4 – 0.8</td>
</tr>
<tr>
<td>Vessel diameter (cm)</td>
<td>1.3 [0.3]</td>
<td>1.3 [0.3]</td>
<td>0.8 – 1.6</td>
<td>0.9 – 1.7</td>
</tr>
<tr>
<td>Maximum blood flow velocity (cm/s)</td>
<td>45.4 [12.5]</td>
<td>50.4 [12.5]</td>
<td>29 – 62</td>
<td>34 – 67</td>
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</tr>
<tr>
<td>Mean blood flow velocity (cm/s)</td>
<td>33.5 [9.5]</td>
<td>32.4 [9.9]</td>
<td>21 – 48</td>
<td>19 – 45</td>
</tr>
</tbody>
</table>

**Doppler observations**

The spectral display was a broad band structure with a wave-like course (Fig 2). The Doppler measurement point was 0.4 to 0.8 cm (mean [sd], 0.5 [0.1] cm) from the body surface. The blood flow velocity did not change significantly after sedation. The maximum blood flow velocity was 45.4 [12.5] cm/s before and 50.4 [12.5] cm/s after sedation (P > 0.05), the mean blood flow velocity was 33.5 [9.5] cm/s before and 32.4 [9.9] cm/s after sedation and the minimum blood flow velocity was 25.8 [11.6] cm/s before and 21.1 [11.3] cm/s after sedation.

There were significant correlations (P < 0.05) between the blood flow velocity before and after sedation for the mean values (r = 0.86) and the maximum values (r = 0.69) but not for the minimum values (r = 0.10). There were also significant correlations between the maximum and mean blood flow velocity (r = 0.94), between mean and minimum blood flow velocity (r = 0.75) and between maximum and minimum blood flow velocity (r = 0.69, P < 0.05).
Figure 2: Colour Doppler sonogram of the milk vein of a healthy seven-year-old Swiss Braunvieh cow before sedation. A longitudinal view of the milk vein with the superimposed colour window/mode is shown above and the corresponding spectral curve below.

Discussion

The milk vein was easily imaged via colour-Doppler sonography because of its proximity to the body surface and its relatively large diameter in the lactating cows. The superficial location and wide diameter allow for successful colour Doppler imaging of a vein (Widder and Goertler 2004). When a beam angle of more than 60° is used, measurement errors occur and the blood flow velocity is overestimated (Arning 2002). The location of the milk vein directly under the skin prevents weakening of the colour signal and large variations in measurements. The accuracy of measurements depends on the type and thickness of the tissue between the transducer and vein and is negatively affected by fat and muscle tissue between the transducer and blood vessel (Hendrickx and others 1990, Ranke and others 1990). The milk vein also has an adequate volume of blood for sonographic measurements. The blood volume is critical; smaller volumes provide fewer signals for Doppler spectrum analysis because of a smaller number of moving blood cells (Widder and Goertler 2004).

The milk vein was easier to examine than the jugular vein. Many cows do not tolerate ultrasonographic examination of the jugular vein well (Föhn 1992, Hoegger 2006), and slight defensive movements of the animal’s head may result in large
measurement errors. Ultrasonographic examination of the milk vein was straightforward in the majority of cows in our study, and most could be restrained quietly using a manual flank-fold grip. Compared with examination of the jugular vein, which required occlusion using a rope or a clamp, the milk vein could be examined without manual occlusion because it is located ventral to the heart and is normally distended (Stöber 1990). The procedure was tolerated well by the cows.

The blood flow velocity in the milk vein is lower than that in the jugular vein (Braun and Föhn 2005, Hoegger 2006). The maximum blood flow velocity in the jugular vein is 55 cm/s (Hoegger 2006) to 65 cm/s (Braun and Föhn 2005), whereas in the milk vein, it is an average of 45 cm/s. Administration of xylazine resulted in an increase in the diameter of the jugular vein and a decrease in the blood flow velocity (Braun and Föhn 2005). The effect of xylazine on blood flow variables has also been investigated in horses (Rutkowski and others 1991), calves (Campbell and others 1979) and goats (Lee and others 1990). The effect of xylazine on blood pressure was studied in cattle (Braun and others 1999). In the milk vein, the effect of xylazine on the blood flow variables was minor and not significant. Thus, there is no need to consider the effects of sedation with xylazine, which is now and then required for the examination of cows. Less variation in blood flow variables allows a more reliable diagnosis of pathological processes. In a cow with tricuspid valvular endocarditis, Doppler sonography of the jugular vein revealed blood flow abnormalities (Föhn 1992). Future studies will focus on colour-Doppler sonography of the milk vein in patients with right-sided cardiac insufficiency, thrombophlebitis and acute mastitis.

References


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