A new heart failure model in rat by an end-to-side femoral vessel anastomosis

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Abstract

Objective: The aim of this study was to develop a new shunting procedure for producing heart failure in the rat incorporating microvascular techniques and avoiding an abdominal operation. Method: We performed an end-to-side anastomosis between the femoral vein and the femoral artery just proximal to their trifurcation into the saphenous, epigastric, and distal femoral vessels. Results: Of the 15 rats which underwent this procedure, six died within 48 h. The nine surviving animals were sacrificed and examined six weeks following surgery. All nine had developed cardiac hypertrophy and cardiac failure. Conclusion: This model provides a relatively simple and reproducible means of creating high output heart failure and cardiac hypertrophy in the rat without necessitating abdominal surgery. © 1998 Elsevier Science B.V.

Keywords: Microsurgery; Rat; Cardiac failure; Arteriovenous shunt

1. Introduction

The rat is a useful experimental animal for investigating cardiac hypertrophy as well as the hemodynamic and endocrine aspects of chronic heart failure [1–7]. Two commonly used surgical methods of inducing heart failure in the rat are ligation of the left coronary artery [5,6] and creation of a fistula between the vena cava and the abdominal aorta [1–4,7]. The drawback of both of these operations is that they require an abdominal laparotomy or thoracotomy [1–7], which subjects the animals to additional stress and trauma. Further, dissections of the abdominal aorta and vena cava are time-consuming and difficult compared to dissection of the peripheral vessels. In this study, we present an easier method of developing heart failure in the rat with acceptable mortality rates and a 100% rate of heart failure development in survivors.

2. Material and methods

We used 500–550 g adult Long-Evans rats. The National Research Council’s guidelines for the use and care of laboratory animals were followed. The animals were anesthetized with 60 mg/kg intraperitoneal sodium pentobarbital injections.

In the 15 rats (average 516 g, Std 17.32) which comprised the experimental group, an end-to-side anastomosis was made between the femoral vein and the femoral artery just proximal to their trifurcation into the saphenous, epigastric, and distal femoral vessels. The distal segment of the transected femoral vein was anastomosed to femoral artery in an end to side fashion in order to increase the venous flow. The diameter of the anastomosis was 2 mm and ten 10.0 nylon sutures were used for anastomosis. Procedure took approximately 20 min. Another group of
Fig. 1. A: Normal anatomy of the femoral vein and femoral artery. B: The procedure.

### Table 1
Comparison of left ventricular diameter and wall thickness values between A–V shunted and control groups

<table>
<thead>
<tr>
<th></th>
<th>Heart weight (g)</th>
<th>Left ventricle diameter (mm)</th>
<th>Left ventricle wall thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1.96 (± 0.25)</td>
<td>7.73 (± 0.48)</td>
<td>2.40 (± 0.26)</td>
</tr>
<tr>
<td>A–V shunt</td>
<td>2.19 (± 0.18)</td>
<td>10.33 (± 1.16)</td>
<td>3.11 (± 0.21)</td>
</tr>
<tr>
<td>( p )</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>&lt; 0.01</td>
</tr>
</tbody>
</table>

15 animals (average 530 g, Std 14.85) without any operation comprised the control group. See Fig. 1.

Six weeks following surgery, the patency of each shunt was verified by the milking test. The animals were then sacrificed, and the hearts were excised and fixed in 10% formalin. After 48 h of fixation, the hearts were weighed, histological sections were taken vertical to the mid point of the interventricular septum and the left ventricle diameter and wall thickness were measured. See Table 1.

### 3. Results

Of the 15 rats in which an arteriovenous shunt was performed, six (40%) died within 48 h of surgery. The remaining nine (60%) rats had patent anastomoses and all these rats developed cardiac hypertrophy. During the 6th week observation and milking test the vein site was found to be dilated and pulsatile. The animals which received arteriovenous shunts had significantly heavier hearts than the normal control group. The left ventricle diameters and wall thickness were also significantly larger in the experimental group than in the control group. The measurements are shown below, and are expressed as means and standard deviation (STD). Significance was determined using the unpaired \( t \) test.

### 4. Discussion

This technique permits creation of high output cardiac failure in the rat leg microsurgical creation of an arteriovenous fistula between peripheral vessels. The fistula itself can be strictly standardized (the diameter of the anastomosis was 2 mm and ten 10.0 nylon sutures were used for anastomosis) and cardiac failure and hypertrophy developed in all survivors. While left ventricle wall thickening indicated the cardiac hypertrophy, left ventricle dilatation indicated cardiac failure. We anticipate that this new technique will be useful for laboratories interested in investigating high output heart failure and cardiac hypertrophy.
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References