PERCUTANEOUS CANNULATION OF THE DORSALIS PEDIS ARTERY

A prospective study

B. HUSUM, T. PALM AND J. ERIKSEN

SUMMARY

Strain-gauge plethysmography was used to determine the systolic arterial pressure in the great toe of 38 patients (aged 23–70 yr) undergoing lung surgery. In eight patients (21%) manual compression of the dorsalis pedis artery reduced the arterial pressure in the great toe to less than 40 mm Hg, and cannulation of the artery was not attempted. In 24 of 30 patients with adequate collateral arterial supply, a Teflon cannula (Venflon 1.20) was inserted percutaneously to the dorsalis pedis artery. Median cannulation time was 160 min. Six patients (25%, 95% confidence limits 10–47%) developed thrombosis of the artery and, in one, unsuccessful cannulation caused thrombosis. In two patients, recanalization of the artery occurred between the 2nd and the 8th day after operation. In four patients, examination 3–5 months after cannulation revealed a persisting decrease in the function of the dorsalis pedis artery. This suggests that the dorsalis pedis artery should not normally be selected for cannulation.

Cannulation of the dorsalis pedis artery (d.p.a.) is used for i.a. pressure monitoring or frequent sampling of arterial blood (Johnstone and Greenhow, 1973). Apart from a 6.7% frequency of thrombosis following cannulation of d.p.a. (Youngberg and Miller, 1976) there are few reported details of the risks of cannulating this vessel.

We have evaluated the frequency of thrombosis of d.p.a. following percutaneous cannulation and the systolic arterial pressure in the great toe in patients in whom d.p.a. was occluded following cannulation.

PATIENTS AND METHODS

Thirty-eight patients (12 female, 26 male) undergoing lung surgery were studied. The age range was 23–70 yr (median 57.5). None of the patients suffered from diabetes mellitus, arterial hypertension or symptoms of arteriosclerotic disease of the legs.

Before cannulation of d.p.a. the arterial pressure was determined simultaneously in the great toe of the foot chosen for cannulation and in the arm. Measurements of the pressure in the great toe were made following successive compression of d.p.a. and the posterior tibial artery. The pressure was determined using a two-channel strain-gauge plethysmograph. A 22-mm wide pneumatic cuff was placed around the proximal phalanx of the great toe and, as a volume detector, a mercury-in-rubber strain-gauge (Parks Electronics, Oregon) was placed around the distal phalanx of the great toe. This method was introduced by Strandness, Radke and Bell (1961) and Strandness and Bell (1965) and was described in detail in the monograph by Gundersen (1972).

If the collateral blood supply was adequate, as indicated by a systolic arterial pressure in the great toe in excess of 40 mm Hg (Lassen et al., 1975) when measured after compression of d.p.a., this artery was cannulated after induction of anaesthesia. A Teflon cannula (Venflon 1.20, Viggo, Sweden) was inserted percutaneously. Only one attempt at cannulation was allowed. The cannula was flushed regularly with heparinized saline.

Postoperative determinations of the arterial pressure in the great toe were performed on the 2nd and 8th day. If the arterial pressure in the great toe, measured with the posterior tibial artery compressed manually, had decreased by more than 25 mm Hg compared with the corresponding value before operation (2.5 times greater than the standard deviation of measurements performed under similar circumstances on different days (Gundersen, 1972; Nielsen, Bell and Lassen, 1972, 1973)) we regarded this as an indication of thrombosis of d.p.a. Throughout the examinations, corrections were made for changes in systemic arterial pressure. In the period after operation the skin of the back of the foot was examined for lesions or haematomata. The patients who developed thrombosis of d.p.a. were re-examined 3–5 months after operation.

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RESULTS
The d.p.a. pulse was palpable in all instances and all the patients had adequate blood supply to the great toe judged by the arterial pressure in the toe. In 25 of 38 patients compression of d.p.a. reduced the arterial pressure in the great toe (collateral supply was unable to compensate completely for the occlusion). In eight of 38 patients (21.1%, 95% confidence limits 9.6-37.3%) the arterial pressure in the great toe decreased to less than 40 mm Hg and consequently the collateral arterial supply was regarded as inadequate, and cannulation of d.p.a. was not attempted. These eight patients were in the same age range as the other patients (44-70 yr v. 23-70 yr).

In the 30 patients with adequate collateral supply cannulation of d.p.a. was performed successfully in 24 patients. The duration of cannulation ranged from 100 to 1800 min (median 160 min). None of the patients showed any evidence of tissue necrosis following cannulation.

Following cannulation of d.p.a., six patients (25%, 95% confidence limits 9.8-46.7%) developed thrombosis of the artery. This also occurred in one of the six patients in whom cannulation of d.p.a. was attempted unsuccessfully. The pressure determinations in the seven patients with thrombosis in the dorsalis pedis artery are shown in table I. Two of these (patients no. 23 and 24) had re-established perfusion through d.p.a. on the 8th day after operation. Four of the remaining five patients were re-examined 3-5 months after the operation; the vessel was still partly occluded (table II) but the collateral circulation was sufficient to ensure an adequate arterial pressure in the great toe.

DISCUSSION
The arterial supply to the foot consists of d.p.a., the posterior tibial artery and, to a lesser extent, the peroneal artery and the malleolar network. Earlier studies have indicated that in 3-14% of subjects d.p.a. cannot be palpated (Reich, 1934; Stephens, 1962; Barnhorst and Barner, 1968; Palm and Husum, 1978). Indeed, anatomical studies have shown d.p.a. to be absent in 3-12% of patients (Huber, 1941). In the present study d.p.a. was palpable in all patients.

Johnstone and Greenhow (1973) recommended cannulation of d.p.a. as a safe and reliable alternative

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**Table I.** Arterial pressure in the great toe, measured after manual compression of the posterior tibial artery, in six patients with thrombosis following cannulation of the dorsalis pedis artery and in one patient (no. 11) with thrombosis following unsuccessfully attempted cannulation of the dorsalis pedis artery

<table>
<thead>
<tr>
<th>Patient no.</th>
<th>Arterial pressure (mm Hg)</th>
<th>After cannulation</th>
<th>Duration of cannulation (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before cannulation</td>
<td>2nd day</td>
<td>8th day</td>
</tr>
<tr>
<td>5</td>
<td>128</td>
<td>27</td>
<td>51</td>
</tr>
<tr>
<td>10</td>
<td>83</td>
<td>84</td>
<td>56</td>
</tr>
<tr>
<td>14</td>
<td>77</td>
<td>52</td>
<td>22</td>
</tr>
<tr>
<td>20</td>
<td>78</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>23</td>
<td>60</td>
<td>20</td>
<td>90</td>
</tr>
<tr>
<td>24</td>
<td>70</td>
<td>20</td>
<td>99</td>
</tr>
<tr>
<td>11</td>
<td>120</td>
<td>56</td>
<td>52</td>
</tr>
</tbody>
</table>

**Table II.** Arterial pressure in the arm and in the great toe determined simultaneously in three patients 3-5 months after development of thrombosis following cannulation of the dorsalis pedis artery. Corresponding pre-cannulation values are shown in brackets. In patient no. 11 the thrombosis developed after unsuccessfully attempted cannulation

<table>
<thead>
<tr>
<th>Patient no.</th>
<th>Arm (mm Hg)</th>
<th>Great toe (mm Hg)</th>
<th>Great toe after compression of posterior tibial artery</th>
<th>Palpable dorsalis pedis artery pulse</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>142 (142)</td>
<td>97 (140)</td>
<td>85 (128)</td>
<td>yes</td>
</tr>
<tr>
<td>14</td>
<td>160 (122)</td>
<td>50 (76)</td>
<td>48 (77)</td>
<td>no</td>
</tr>
<tr>
<td>20</td>
<td>154 (138)</td>
<td>103 (86)</td>
<td>40 (78)</td>
<td>no</td>
</tr>
<tr>
<td>11</td>
<td>140 (150)</td>
<td>105 (108)</td>
<td>62 (120)</td>
<td>yes</td>
</tr>
</tbody>
</table>
to routine cannulation of the radial artery for monitoring purposes. They suggested that the existence of sufficient collateral flow could be evaluated by observing capillary refilling upon release of toe compression, but this test is difficult to use, especially when the feet are cold (Palm and Husum, 1978). Using a photoelectric pulse pick-up to detect collateral flow in the second toe following manual compression of d.p.a. Spoeerl, Deimling and Aitken (1975) found that in 16% of patients d.p.a. appeared to carry almost the entire flow to the toes. In a recent study of the arterial dominance in the foot using strain-gauge plethysmography (Palm and Husum, 1978) no difference was found in the frequency with which d.p.a. or the posterior tibial artery dominated the arterial supply to the great toe.

Previous studies have not reported the number of patients in whom cannulation of d.p.a. was not performed because of inadequate collateral supply (Johnstone and Greenhow, 1973; Spoeerl, Deimling and Aitken, 1975; Youngberg and Miller, 1976). A recent study of 100 young healthy subjects (Palm and Husum, 1978) demonstrated a 2% frequency of inadequate collateral supply as judged by a decrease in arterial pressure in the great toe to less than 40 mm Hg after manual compression of d.p.a. The 21% frequency of inadequate collateral supply found in the present study may be ascribed at least in part to the difference in age in the populations studied.

Our success rate of 80% (24 of 30) of attempted cannulations compares well with those reported by Johnstone and Greenhow (1973) (21 of 26) and by Youngberg and Miller (1976) (26 of 30).

The present study showed that despite a median cannulation time of only 160 min, the frequency of thrombosis of d.p.a. was as high as 25%. Using a Doppler flow technique Youngberg and Miller (1976) found thrombosis of d.p.a. in 6.7% of 30 patients after an average cannulation time of 492 min. Spoeerl, Deimling and Aitken (1975) observed no complications in more than 100 patients following cannulation of d.p.a. for the duration of neurosurgical procedures. However, they did not quote the frequency of thrombosis of the artery or the cannulation time.

Signs of thrombosis of d.p.a. may develop some days after cannulation, but recanalization may occur (table I). In a study of cannulation of the radial artery Bedford and Wollmann (1973) found that thrombosis of the radial artery might develop as late as 7 days after removal of the cannula, and that recanalization of the vessel would occur most often within 70 days.

The results in table II indicate that, although the collaterals were sufficient to maintain arterial pressure in the great toe above critical values (40 mm Hg) 3–5 months after cannulation, the d.p.a. in none of these patients functioned as well as before cannulation. None of the patients had symptoms of inadequate blood supply to the feet.

Our present findings indicate that in 21% (10–39%) of our patients it would probably be unsafe to cannulate d.p.a. for monitoring purposes, as manual compression of the vessel would reduce the arterial pressure in the great toe to less than 40 mm Hg. If thrombosis should occur in the artery, the blood supply to the great toe could be permanently jeopardized. Of the patients with adequate collateral supply, 80% could probably be cannulated at the first attempt and 25% (10–47%) of these would develop thrombosis of d.p.a.

Because of these findings and because, in the older age group, arteriosclerosis may further adversely affect collateral circulation in the foot, we conclude that the dorsalis pedis artery should not be selected as a routine site for arterial cannulation.

ACKNOWLEDGEMENT

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REFERENCES


**POSE SOUS-CUTANEE D'UNE CANULE DANS L'ARTERE PEDIEUSE**

*Une étude en perspective*

RESUME

On a utilisé un pléthysmographe pour déterminer la pression artérielle systolique dans le gros orteil de 38 malades (âgés de 23 à 70 ans) subissant une intervention chirurgicale aux poumons. Sur 8 malades (21%), la compression manuelle de l'artère pédieuse a permis de réduire la pression artérielle dans le gros orteil à moins de 40 mm Hg et l'on n'a pas essayé de leur poser une canule dans l'artère. Sur 24 malades (parmi les 30 autres), ayant un débit artériel collatéral adéquat, on a inséré d'une manière sous-cutanée une canule en teflon (Venflon 1,20) dans l'artère pédieuse. Le temps moyen pendant lequel on a laissé la canule a été de 160 min. Six malades (25%, 95% des limites de confiance 10-47%) ont eu une thrombose de l'artère et, sur une personne, le fait de ne pas être arrivé à insérer la canule a provoqué une thrombose. Sur deux malades, la recanalisation de l'artère a été faite entre le deuxième et le huitième jour suivant l'intervention. Sur quatre malades, un examen effectué de 3-5 mois après la pose de la canule a révélé une diminution persistante de la fonction de l'artère pédieuse. Ceci permet de dire que l'artère pédieuse ne doit normalement pas être choisie pour la pose d'une canule.

**PERKUTANE KANÜLENEINFÜHRUNG IN DIE DORSALIS PEDIS-ARTERIE**

*Eine vorbereitende Studie*

ZUSAMMENFASSUNG

Filterlehre-Plethysmographie wurde verwendet, um den systolischen arteriellen Druck in der grossen Zehe von 38 Patienten (23-70 Jahre alt) bei Lungenoperationen zu bestimmen. Bei acht Patienten (21%) wurde durch manuellen Druck auf die dorsalis pedis-Arterie der arterielle Druck in der grossen Zehe auf unter 40 mm Hg reduziert, und Kanüleninfektion in die Artérte wurde nicht versucht. Bei 24 von 30 Patienten mit ausreichender arterieller Blutzufuhr wurde eine Teflonkanüle (Venflon 1,20) perkutan eingeführt, mit einer mittleren Einführungszeit von 160 min. Sechs Patienten (25%, 95% Vertrauensgrenzen 10-47%) entwickelten eine Thrombose der dorsalis pedis-Arterie, und bei einem Patienten bewirkte eine erfolglose Kanüleninfektion eine Thrombose. Bei zwei Patienten erfolgte die Rekanalisation der Arterie zwischen zweitem und achten Tag nach dem Eingriff. Bei vier Patienten stellte man 3-5 Monate nach Kanüleninfektion eine beständige Funktionssenkung der Arterie fest, was andeutet, dass die dorsalis pedis-Arterie normalerweise nicht für Kanüleninfektion gewählt werden sollte.

**CANULACION PERCUTANEA DE LA ARTERIA PEDIA**

SUMARIO

Se usó la plethysmografía de medidor de presión para determinar la presión arterial sistólica en el dedo grueso del pie de 38 pacientes (de 23 a 70 años de edad) sometidos a cirugía pulmonar. En ocho pacientes (21%), la compresión manual de la arteria pedia redujo la presión arterial en el dedo grueso del pie hasta menos de 40 mm Hg, y no se intentó la canulación de la arteria. En 24 de los 30 pacientes con flujo arterial colateral adecuado, se introdujo percutáneamente una cánula de Teflón (Venflon 1,20) en la arteria pedia. El tiempo medio de canulación fue de 160 min. En seis pacientes (25%, con límites confiables del 95%, 10-47%) se registraron señales de trombosis de la arteria y en uno, falló la canulación, lo que causó trombosis al paciente. En dos pacientes, la reanudación de la arteria ocurrió entre el segundo y el octavo día después de la operación. En cuatro pacientes, el examen efectuado de 3 a 5 meses después de la canulación reveló una disminución persistente de la función de la arteria pedia. Esto indica que normalmente no se debe escoger la arteria pedia para efectuar canulaciones.