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GYNECOLOGIC ONCOLOGY **70,** 358–364 (1998)
ARTICLE NO. GO985073

Anatomosurgical Implications Derived from an Embryological Study of the Scarpa's Triangle with Particular Reference to Groin Lymphadenectomy

Leonardo Micheletti, M.D.,* Alessandro Cesare Levi, M.D.,† and Fabrizio Bogliatto†

**Department of Gynaecology and Obstetrics and †Department of Human Anatomy, Pharmacology and Forensic Medicine, University of Torino, Torino, Italy*

Received September 29, 1997

Objective. **To clarify some anatomical controversies of the fascial structures and lymph node development of the inguinal region through an embryological study in relation to the surgical techniques of groin lymphadenectomy.**

Methods. **Sections of the femoral triangle belonging to four fetuses whose crown–rump (CR) length ranged from 70 to 310 mm, corresponding to a developmental age of 11 and 35 weeks, were studied.**

Results. **The femoral fascia is formed of one layer and is not divided into superficial and deep layers. The cribriform fascia has a morphogenetic origin different from that of the femoral fascia and it is defined by the thickening of the connective tissue filling the fossa ovalis and therefore would be more correctly named lamina cribrosa. The deep inguinal lymph nodes originate directly from the superficial lymphatic tissue located in the fossa ovalis. This last observation supports the fact that no lymph nodes are present beneath the femoral fascia distal to the lower margin of the fossa ovalis.**

Conclusions. **The results of this study, from a surgical point of view, support the technique of total or radical inguinal–femoral lymphadenectomy with preservation of the femoral fascia and, from an anatomical point of view, resolve some of the contradictory statements reported in the anatomical literature regarding morphogenesis and terminology of the structures of the Scarpa's triangle. In addition, the present study provides useful anatomic and terminological landmarks to those surgical oncologists (gynecologist, urologist, dermatologist, etc.) dealing with malignant diseases requiring groin dissection practices. In addition, it could represent a useful background for a future more precise surgical terminology which represents a vital issue for institutional studies with multiple surgeons as well as for large multi-institutional studies.**

INTRODUCTION

Recently Levenback *et al.* [1] have clearly shown that in the surgical management of vulval cancer among the gynecologic oncologists, important controversies regarding both the extent of the groin dissection and the name of the surgical procedures exist. These controversies are mainly due to the discrepancy between the anatomotopographic descriptions of the structures of Scarpa's triangle found in the classic anatomy textbooks [2–5] and the anatomical knowledges derived from the surgical practice.

Borgno *et al.* [6] added significant new findings to the understanding of the lymph node anatomy of the groin by dissecting the inguinofemoral triangles of 50 female cadavers and demonstrating that the deep femoral nodes are always situated within the opening of the fossa ovalis medial to the femoral vein and that no lymph nodes are present distal to the lower margin of the fossa ovalis and lateral to the femoral vein.

Therefore total inguinal lymphadenectomy can be performed without removing the fascia lata. According to these findings Micheletti and co-workers [7] demonstrated that inguinofemoral lymphadenectomy with the preservation of the fascia lata in the treatment of invasive vulval cancer is as effective as the more aggressive Way's technique [8].

Although Borgno *et al.* [6] and Micheletti *et al.* [7] studies added important knowledge on topographic distribution of Scarpa's lymph nodes, some discrepancies as remarked by Levenback and co-workers [1] still exist in their interpretation of the fascial structures of the Scarpa's triangle. Because of the need for a more precise anatomic and surgical terminology, as recently emphasized by some authors [1, 9], the chance of having available some fetuses of different age, and the belief that combining anatomical and surgical expertise could improve clinical knowledge, we decided to reinvestigate, from an embryological point of view, the fascial structure and lymph node development of the inguinal region.

MATERIALS AND METHODS

At the Institute of Human Anatomy of the University of Torino eight fetuses, whose crown–rump (CR) lengths ranged from 70 to 310 mm, corresponding respectively with a developmental age of 11 to 35 weeks, were available. All the fetuses were fixed in Zencker's solution and to obtain decalcification, those starting from CR 145 mm were treated with EDTA.

One hundred to 200 20-μm sections of paraffin-embedded craniocaudal serial sections of the femoral triangle, stained with hematoxylin–eosin and Azan–Mallory, were available

0090-8258/98 $25.00

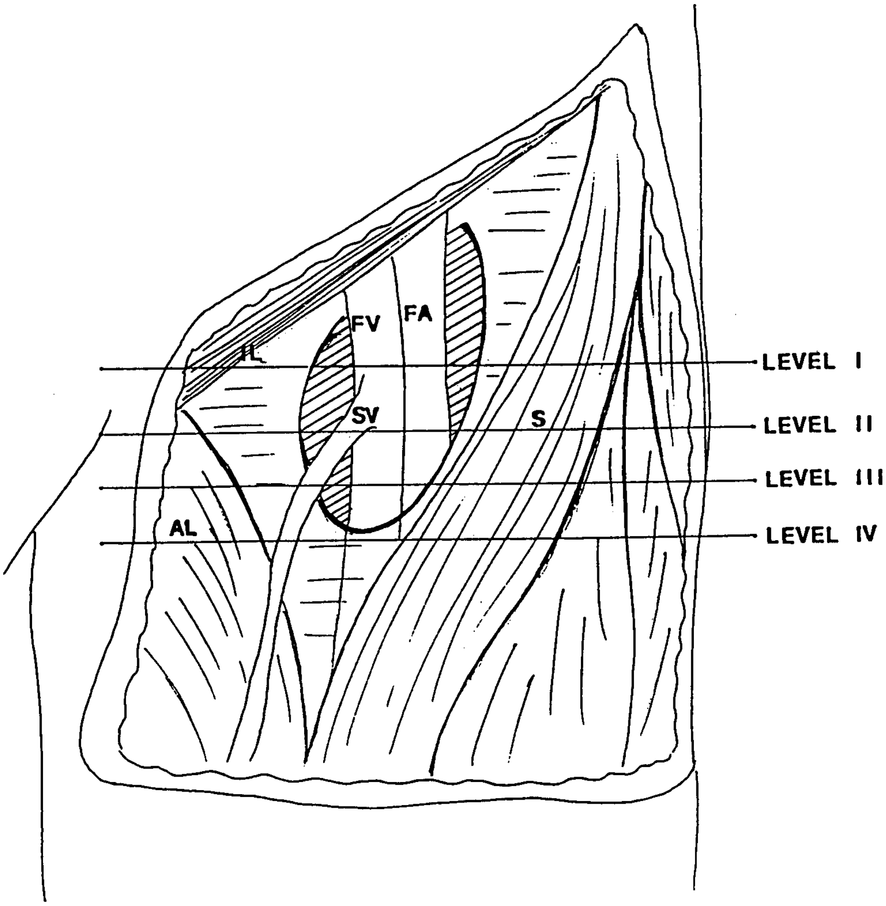


FIG. 1. Level of the sections. Level I refers to the sections illustrated in Figs. 2 and 4a. Level II refers to the sections illustrated in Figs. 3, 4b, 5a, and 6. Level III refers to Figs. 4c and 5b. Level IV refers to Fig. 5c. FA, femoral artery; FV, femoral vein; SV, saphenous vein; IL, inguinal ligament; AL, adductor longus muscle; S, sartorius muscle; hatched area, fossa ovalis.

from each fetus. These sections had been prepared by one of the authors (A.C.L.) for a previous study published in 1976 regarding the morphogenic development of the femoral triangle's fascial structures [10]. The present investigation included four of these fetuses (CR: 85, 130, 220, and 310 mm) because the remaining four (CR: 85, 110, 170, and 185 mm) provided no useful information. The most representative and best preserved sections of these four fetuses were selected to evaluate the correlation between fascial structures and lymph nodes of the femoral triangle. Particular attention was paid in selecting sections that were at identical anatomical sites in each fetus.

In Fig. 1 the levels of the different sections are illustrated to demonstrate the progression in the development of the femoral triangle. In some of the other figures a broken line has been used to mark off the different fascial structures since they are not always clearly discernible.

RESULTS

Specimen 1 (Fig. 2: CR 70 mm, corresponding to 11 weeks after ovulation). In this specimen the superficial fascia of the inguinal region is not yet evident; there is only a collagenization (c) lying on the muscles. However, the femoral fascia begins to be visible as well as an end, indicated by the arrow, which will become the Allan Burns ligament. At this developmental stage, many small cavities or lacunae are present; some of these lacunae have a mesenchymal origin (lm) while others are lymphatic buds (ll) as demonstrated by the presence of lymphocytes on the inside. These lacunae predominate the femoral triangle. The broken line, traced by the end of the femoral fascia, indicates the site where the cribriform lamina will develop.

Specimen 2 (Figs. 3 and 4: CR 130 mm, corresponding to 15 weeks after ovulation). At this developmental stage both the superficial fascia (indicated by the broken line), splitting the fat of the inguinal region in two layers, and the femoral fascia (indicated by the arrow) become clearly recognizable (Fig. 3). On a craniocaudal examination of the serial sections the lymph nodes first show (Fig. 4a) the presence of two heaps of lymphocytes (ll), which grow to four (Fig. 4b) and become again two in the more distal portion of the specimen (Fig. 4c). All the cords of dense lymphoid tissue are lying above the line of the femoral fascia (indicated by the arrow). It is noteworthy that the medial node

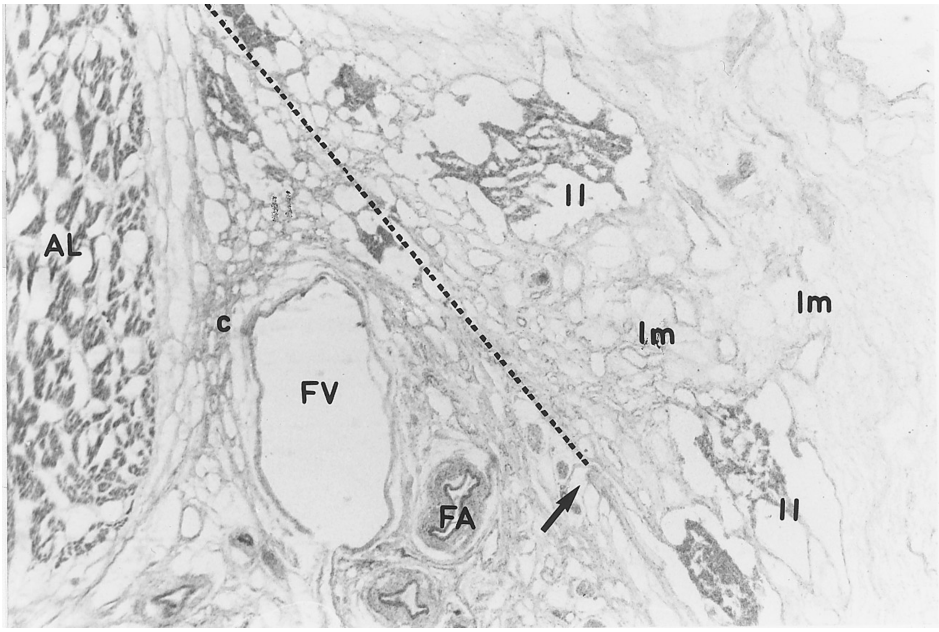


FIG. 2. Human fetus, CR 70 mm, corresponding to 11 weeks after ovulation. Right femoral triangle. Level I. (×40, hematoxylin–eosin stain). FA, femoral artery; FV, femoral vein; AL, adductor longus muscle; c, collagenization zone; ll, lymphatic lacunae; lm, mesenchymal lacunae. Arrow indicates femoral fascia ending; broken line indicates site where the cribriform lamina will develop.

present in Fig. 4b, partially enveloping the saphenous vein, shows an offshoot in depth moving toward the femoral vein.

Specimen 3 (Fig. 5: CR 220 mm, corresponding to 23–24 weeks after ovulation). At this developmental age, the superficial fascia (fine arrow) and the femoral fascia (broad arrow) have reached their definitive shape. Unlike the lymph nodes whose shape, position and number is still under an active rearrangement, which is clearly demonstrated comparing the CR 130- and 220-mm specimens.

Figures 4a–4c show the distinct, separate nodes found at CR

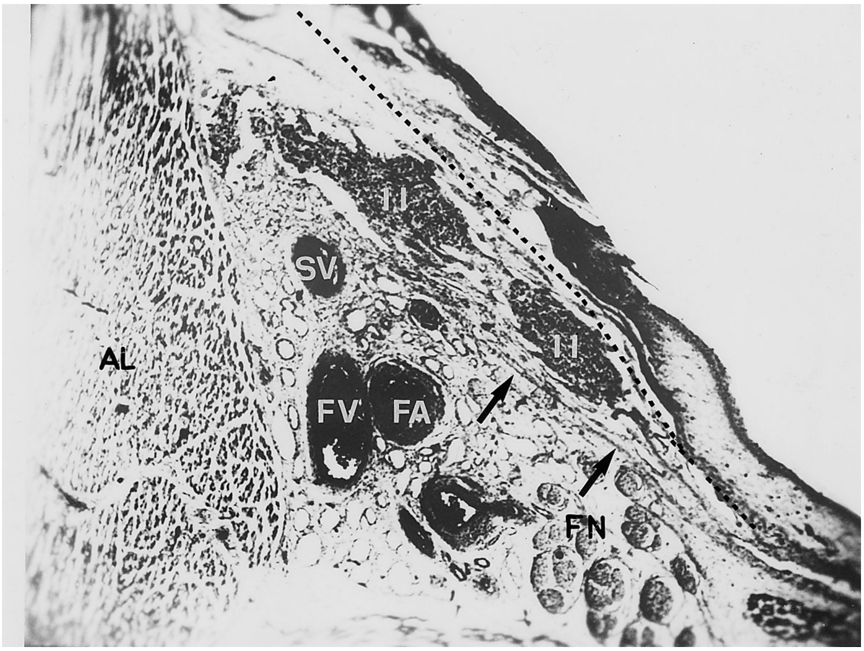


FIG. 3. Human fetus, CR 130 mm, corresponding to 15 weeks after ovulation. Right femoral triangle. Level II (×40, Azan–Mallory stain). FA, femoral artery; FV, femoral vein; FN, femoral nerve; SV, saphenous vein; AL, adductor longus muscle; ll, lymphatic buds. Arrows indicate femoral fascia; broken line indicates superficial fascia.

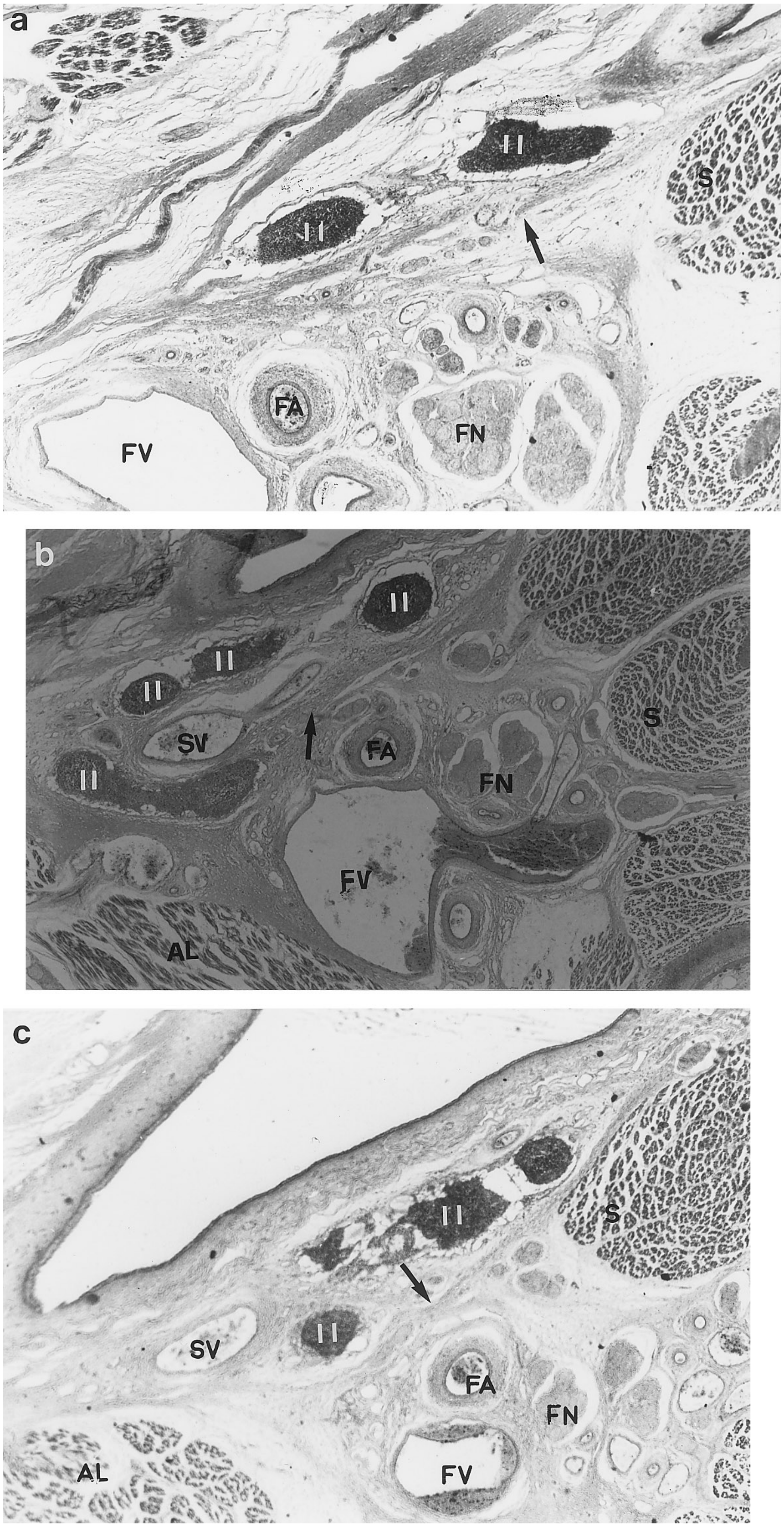
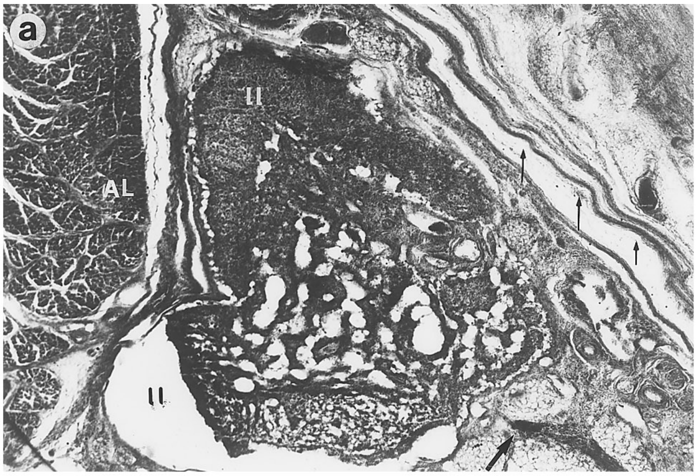
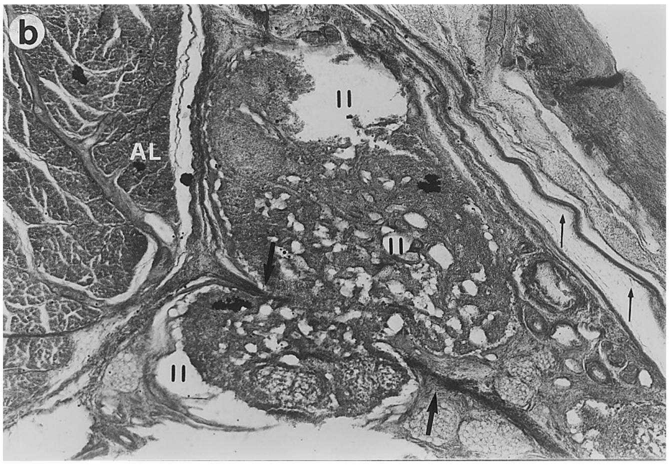


FIG. 4. (a) Human fetus, CR 130 mm, corresponding to 15 weeks after ovulation. Right femoral triangle. Level I (×40, Azan–Mallory stain). FA, femoral artery; FV, femoral vein; FN, femoral nerve; S, sartorius muscle; ll, lymphatic buds. Arrow indicates femoral fascia ending. (b) Human fetus, CR 130 mm, corresponding to 15 weeks after ovulation. Right femoral triangle. Level II (×40, Azan–Mallory stain). Abbreviations for band c: FA, femoral artery; FV, femoral vein; SV, saphenous vein; FN, femoral nerve; AL, adductor longus muscle; S, sartorius muscle; ll, lymphatic buds; arrow indicates femoral fascia ending. (c) Human fetus, CR 130 mm, corresponding to 15 weeks after ovulation. Right femoral triangle. Level III (×40, Azan–Mallory stain).





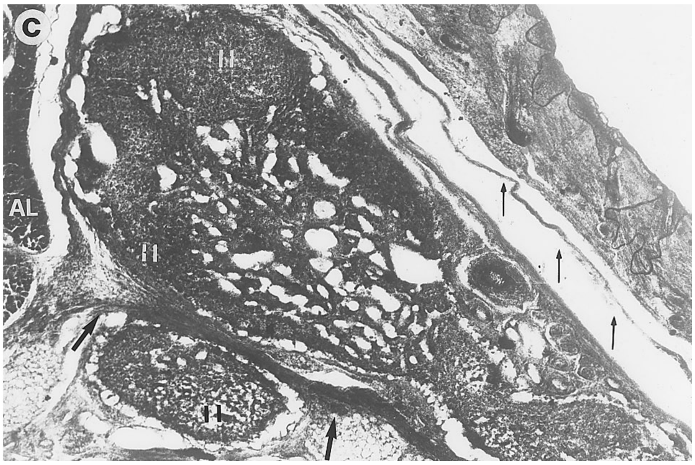


FIG. 5. (a) Human fetus, CR 220 mm, corresponding to 23–24 weeks after ovulation. Right femoral triangle. Level II (×40, Azan–Mallory stain). (b) Human fetus, CR 220 mm, corresponding to 23–24 weeks after ovulation. Right femoral triangle. Level III (×40, Azan–Mallory stain). (c) Human fetus, CR 220 mm, corresponding to 23–24 weeks after ovulation. Right femoral triangle. Level IV (×40, Azan–Mallory stain). Abbreviations for a–c: AL, adductor longus muscle; ll, lymphatic buds. Fine arrows indicate superficial fascia; broad arrows indicate femoral fascia.

130 mm which are ultimately changed into an amorphous mass of lymphatic tissue at CR 220 mm (Fig. 5a).

In Fig. 5a, the deepening into the fossa ovalis of the superficial lymphatic bud can be now identified as a big lymph node. This deepening is probably facilitated by the presence of a flail of embryonic connective tissue and by the reorganization and growth of the lymphatic tissue in the area of the fossa ovalis. In Fig. 5b, the initial strangling of this superficial lymph node is evident (indicated by the broad arrow) and it is due, at this level, to the progressive organization of the connective fibers of the fossa ovalis. In Fig. 5c, the lymph node located under the femoral fascia is not separated from the one illustrated in the previous two figures, but it is the result of its protrusion and sliding through the connective fibers of the fossa ovalis.

Specimen 4 (Fig. 6: CR 310 mm, corresponding to 35 weeks after ovulation). In Fig. 6, two lymph nodes, one lying above and the other beneath the line of the femoral fascia (indicated by the broad arrow), situated in the fossa ovalis are illustrated. This clear separation between the two nodes is due to the completion of the progressive thickening of the flail connective tissue covering the fossa ovalis, which will finally become the structure known as the cribriform lamina (indicated by the fine arrow).

DISCUSSION

The results of the present study may provide useful information for a more precise understanding of the anatomy of the Scarpa’s triangle and consequently for a better surgical terminology. The present data show that the femoral fascia is a single layer which extends over the Scarpa’s triangle and become clearly evident at 11 weeks of a developmental age (Fig. 2). In the superomedial part of the triangle the development of the femoral fascia stops forming a definite margin. This well-marked medial termination, already evident in the CR 70-mm fetus (Fig. 2), is probably due both to the early presence in this region of abundant lymphatic tissue and to the junction of the saphenous vein into the femoral vein.

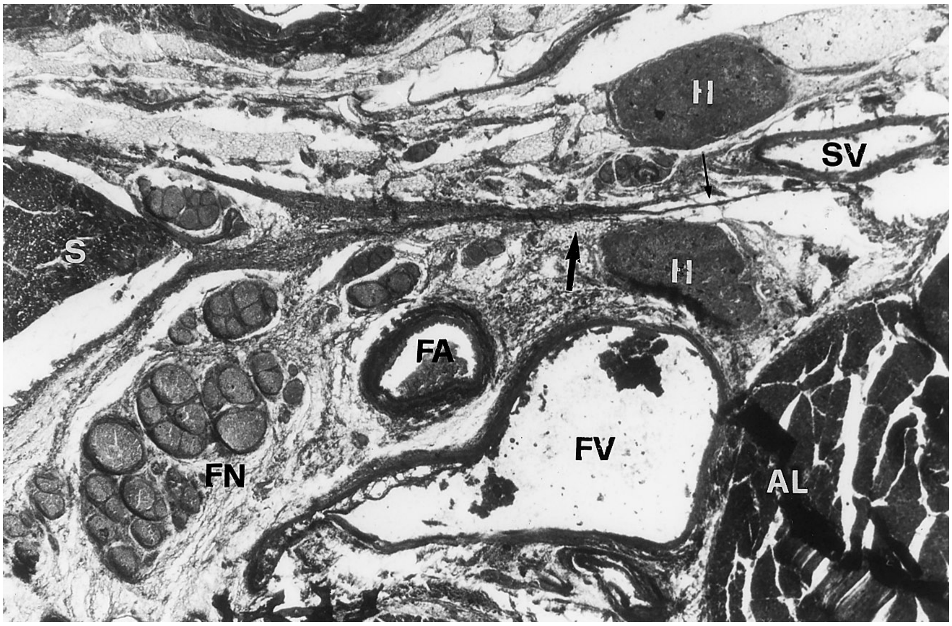


FIG. 6. Human fetus, CR 310 mm, corresponding to 35 weeks after ovulation. Left femoral triangle. Level II (×30, Azan–Mallory stain). FA, femoral artery; FV, femoral vein; SV, saphenous vein; FN, femoral nerve; AL, adductor longus muscle; S, sartorius muscle; ll, lymph nodes. Broad arrow indicates femoral fascia; fine arrow indicates cribriform lamina.

This falciform margin, bent medially, remains thick in the mature fetus, is named Allan Burns or Hey ligament and defines the fossa ovalis.

A perforated structure usually named cribriform fascia covers the fossa ovalis and has been considered by most authors [2, 4, 11, 12, 13] from a morphogenetic point of view as a part of the femoral fascia.

In contrast with these authors and according to a few researchers [3, 14], our data show that the cribriform fascia is a thickening of the flail connective tissue covering the fossa ovalis and is not part of the femoral fascia, nor of the superficial fascia dividing the subcutaneous fatty tissue in two layers.

This different embryogenesis of the cribriform fascia from the femoral fascia should, in our opinion, have a different terminology. Instead of "fascia" the term "lamina" would be more appropriate. Actually the term fascia usually indicates a sheet of fibrous tissue while the term lamina indicates a thin layer and it implies a meaning of something thinner than a fascia. Therefore the cribriform fascia should be more correctly renamed the cribriform lamina.

As a consequence the definition offered by Borgno *et al.* [6] that, "the roof of the deep portion of Scarpa's triangle is formed by the cribriform fascia, which is a portion of the fascia lata," is an anatomical and terminologic mistake. However, these authors derived their anatomical knowledge from the main textbooks of anatomy: this fact demonstrates that the anatomical knowledge should not be always taken for granted and not copied from paper to paper and book to book without criticism.

The embryological data of this study confirm the anatomical study of 50 female cadavers published by Borgno *et al.* [6] showing that the femoral lymph nodes are always situated within the fossa ovalis and that lymph nodes are not located beneath the femoral fascia distal to the lower margin of the fossa ovalis. In fact we never found lymphatic tissue under the femoral fascia. As can be seen in Fig. 2, the lymphatic buds at 11 weeks after ovulation are lying only above the line of the femoral fascia. Therefore on the basis of these early embryological findings it can be assumed that the deep femoral lymph nodes originate from the superficial nodes. The examination of a fetus corresponding to 23–24 weeks after ovulation (Fig. 5) clearly demonstrates that the deep femoral nodes derive from the deepening of the superficial nodes, and at this stage are represented by a solitary mass of lymphatic tissue in the fossa ovalis. This deepening is promoted by the growth of the lymphatic tissue through the site of minimal resistance represented by the fossa ovalis. In this area the completion of the progressive thickening of the flail connective tissue, which will represent the cribriform lamina, separates the lymphatic tissue into single lymph nodes. This mechanism is probably in action during the postnatal development and may account for the individual variation and increase in number of lymph nodes in the adult.

A precise embryologic and anatomic understanding of the Scarpa's triangle specifically addressed to lymph nodes and fascial structures represents vital surgical knowledge for those surgeons dealing with malignant disease requiring groin dissection practices. In addition, a precise anatomic understanding and terminology could improve the exchange among different individual surgeons. With particular references to vulval neoplasias, inguinofemoral lymphadenectomy in the surgical management of vulval squamous invasive carcinoma has represented the most important factor in improving survival.

The studies of Taussig [15] and Way [16] published at the end of the 1940s showed improvement in the 5-year survival rate from 20 to 60% in women treated by radical vulvectomy and bilateral inguinal lymphadenectomy. This then became established as the standard curative treatment for any invasive carcinoma of the vulva. The Way's classic technique of total inguinal lymphadenectomy consists of removing several anatomical structures, including the sartorius muscle fascia, the fat lying lateral to the femoral artery, the femoral fascia from the sartorius to the adductor longus muscle, and the fascia of the latter. In addition, the sartorius muscle was detached at its origin at the anterior superior iliac spine and moved to cover the femoral vessels by suturing the free upper end to the inguinal ligament [8].

Unfortunately this technique is accompanied by important complications which lead many authors to propose modifications of the groin dissection ranging from omission [17, 18] to superficial groin dissection [19].

However, some of these conservative proposals may compromise survival. There is no doubt that an ideal groin dissection should remove all the groin lymph nodes (superficial and deep) with minimal disruption to normal tissues. The embryological results of this study, combined with the topographical study of Borgno *et al.* [6], give further support to the surgical technique of total groin lymphadenectomy with the preservation of the femoral fascia, rationalized by Micheletti and coworkers [7].

This technique using separate groin incision can be considered on the one hand surgically conservative and on the other hand oncologically sound. However, a criticism regarding the use of an inappropriate anatomical terminology to Micheletti *et al.* study must be moved on the light of the results of the present study.

These authors on the basis of the current anatomical knowledge employed the term "fascia cribrosa" not distinguishing the "lamina cribrosa" from the "femoral fascia" which is a portion of the fascia lata. This incorrect terminology does not compromise the efficacy of their surgical procedure but, as recently pointed out by Levenback *et al.* [1], increases confusion in the names given to the various dissection practices mainly by the use of inappropriate terms in the definition of Scarpa's triangle anatomic landmarks.

The results of this embryological study hopefully clarify some anatomical issues from a morphogenetic point of view, giving a more appropriate terminology of some Scarpa's triangle landmarks with surgical relevance:

1. The femoral fascia does not divide into a superficial and deep layers as reported in many anatomy text books.
2. The cribriform fascia displays not only a different composition but also a different embryological derivation from that of the femoral fascia (fascia lata portion); therefore, the term cribriform lamina would be a more appropriate term to define the thickening of the connective tissue covering the fossa ovalis.
3. The deep inguinal lymph nodes originate directly and not independently from the superficial lymphatic tissue originally located in the fossa ovalis above the line of the femoral fascia.

As a consequence the present study may provide also useful anatomic and terminological landmarks to those surgical oncologists (gynecologist, urologist, dermatologist, etc.) dealing with malignant diseases requiring groin dissection practices.

Finally, we hope that this study could represent a useful background for a future more precise surgical terminology which represents a vital issue for institutional studies with multiple surgeons as well as for a large multi-institutional studies.

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