Published in final edited form as:

AJR Am J Roentgenol. 2018 November ; 211(5): 1051–1057. doi:10.2214/AJR.18.19683.

Preoperative CT Findings and Interobserver Reliability of Fournier Gangrene

David H. Ballard¹, Constantine A. Raptis¹, Jarot Guerra², Laurie Punch², Obeid Ilahi², John P. Kirby², and Vincent M. Mellnick¹

¹Mallinckrodt Institute of Radiology, Washington University School of Medicine, 510 S Kingshighway Blvd, Campus Box 8131, St. Louis, MO 63110.

²Department of Surgery, Washington University School of Medicine, St. Louis, MO.

Abstract

OBJECTIVE.—The objective of our study was to delineate CT findings and anatomic areas of involvement of surgically proven Fournier gangrene (FG) and determine interobserver reliability.

MATERIALS AND METHODS.—This study was a single-center retrospective study of patients with FG who underwent CT before surgical débridement of FG during a 9-year period. Thirty-eight patients with FG, 17 male and 21 female patients, underwent preoperative CT. Two radiologists reviewed the CT studies and recorded findings and anatomic areas of involvement. CT findings were categorized according to a previously described CT scoring system for necrotizing fasciitis and included the presence or absence of fascial air, muscle or fascial edema, fluid tracking, lymphadenopathy, and subcutaneous edema. Cohen kappa was calculated for interobserver reliability.

RESULTS.—Mean body mass index (BMI [weight in kilograms divided by height in meters squared]) was 42, and 22 of 38 (58%) patients had diabetes. Mean BMI and proportion of patients with diabetes were significantly higher in female patients (mean BMI = 46; 16/21 with diabetes) than male patients (mean BMI = 36; 6/17 with diabetes). CT studies of most patients showed fascial air (36/38 [95%], both readers 1 and 2). Interobserver reliability was substantial to almost perfect for all CT findings except lymphadenopathy, for which it was fair ($\kappa = 0.37$). Genital, perineal, and ischiorectal involvement were seen in 87% (33/38), 87% (33/38), and 32% (12/38) of patients for reader 1 and 84% (32/38), 84% (32/38), and 26% (10/38) of patients for reader 2 ($\kappa = 0.29$, penis; $\kappa = 0.65$, scrotum; $\kappa = 0.91$, vulva and labia; $\kappa = 0.68$, perineal involvement; $\kappa = 0.80$, ischiorectal involvement).

CONCLUSION.—Most CT findings of FG and anatomic areas of involvement showed good interobserver reliability. A high proportion of female patients with FG were observed in this study compared with prior series.

Keywords

acute care surgery; CT; Fournier gangrene; necrotizing fasciitis; radiology

Fournier gangrene (FG) is a genitourinary necrotizing fasciitis that is fatal if not promptly diagnosed and surgically débrided. FG is typically a male-predominant disease in prior series, with only 3–21% of FG cases occurring in female patients [1–3]. Although the FG diagnosis is often clinical, CT is occasionally performed to diagnose FG, assess disease extent, or plan the surgical approach. The presence of fascial gas on CT, along with other findings of inflammation, allows radiologists to raise concern for this diagnosis, but differentiating between necrotizing and nonnecrotizing soft-tissue infections can be difficult for both clinicians and radiologists. This diagnostic challenge and the potential for severe consequences when a diagnosis is missed have led to the development of clinical and radiologic scoring systems for the diagnosis of FG [4–7].

There are few studies that report imaging findings associated with FG [4, 8–11]. In several surgical series, investigators state in the Methods section that imaging was used selectively in patients with FG but often do not report how many patients underwent imaging or what imaging technique was performed [12–14]. Our clinical experience has been that FG is commonly evaluated with preoperative CT and occurs in female patients more frequently than reports in the literature suggest. The purpose of our study was to examine the frequency of the described CT findings of FG, detail the anatomic areas of involvement in male and female patients, and determine interobserver reliability of preoperative CT findings and anatomic areas of involvement in patients with surgically proven FG.

Materials and Methods

This institutional review board–approved single-center retrospective study was conducted in accordance with the HIPAA. The need to obtain informed consent was waived. Data were retrospectively queried from a prospectively maintained acute care surgery database for patients admitted with FG who underwent CT before initial surgical débridement from 2007 through 2015 at Barnes Jewish Hospital. The following International Classification of Diseases codes were used to identify the potential cohort: Fournier gangrene, necrotizing fasciitis, and cellulitis. From this initial query, patient charts were reviewed to identify patients with FG, which was defined in this study as necrotizing fasciitis detected at surgical débridement (reference standard for present study) involving one or more of the following fascial planes: scrotum, penis, vulva, or labia (genitals); perineum; or ischiorectal fossa. The definition of FG as a necrotizing fasciitis of perineal, genital, or perianal regions was adapted from highly cited sources [1, 15], although the definition has evolved from its first description and controversy about the definition exists [1]. Confirmation of necrotizing fasciitis in these fascial planes was by description of necrotic tissue in the operative note. If there was question of fascial involvement (e.g., the description of necrotic tissue was “groin” but did not specify perineal involvement), an attending acute care surgeon reviewed the operative note and clinical information to confirm or refute the diagnosis of FG. The surgical database was chosen for the search rather than the radiology information system because the reference standard for diagnosis was surgical confirmation. Patients with a preoperative CT examination from an outside institution who were transferred to our center for surgical management were included if the CT examination was available in our PACS. Exclusion criteria were patients who had undergone operative débridement before CT, those with

preoperative CT studies from outside institutions that were not available for review, and those who did not undergo surgical débridement.

During the study period, there were 76 patients with FG at our institution, including 38 (50%) patients who underwent preoperative CT. This group included 17 male and 21 female patients with a mean age of 52 years (range, 17–89 years). CT examinations included CT of the abdomen and pelvis and CT of the pelvis with or without IV contrast material. Most (29/38 [76%]) CT examinations included both the abdomen and pelvis; the remaining nine (24%) patients had a CT examination of only the pelvis. For 26 (68%) CT studies, IV contrast material was used. CT studies were acquired with a variety of different scanners and protocols throughout the 9-year study period; however, all CT studies performed were diagnostically adequate for inclusion in the study. The study readers determined diagnostic adequacy. No specific slice thickness criterion was used; however, all studies had a slice thickness of 3 mm or less. Three patients underwent CT at an outside institution, and their studies were uploaded to our PACS.

After identification of the eligible study population, two board-certified, body-subspecialized fellowship-trained radiologists with 10 years (reader 1) and 12 years (reader 2) of experience independently reviewed the preoperative CT studies after reviewing an instructional presentation prepared by one of the authors. The readers were aware the study population was composed of surgically confirmed cases of FG but were blinded to all clinical data and radiology interpretations. Imaging findings and anatomic areas of involvement were recorded by each reader. CT studies were interpreted on a PACS using the Vitrea Enterprise Suite (Vital Images, version 6.7).

A previously described CT grading system for necrotizing fasciitis, the necrotizing soft-tissue infection (NSTI) score, was used to record and score radiologic findings previously described to be predictive of necrotizing fasciitis [4]. A cumulative score based on the proposed NSTI CT scoring system of 6 or greater is suggestive of necrotizing fasciitis. Numeric scores include 5 points for fascial air, 4 points for muscle or fascial edema, 3 points for fluid tracking, 2 points for lymphadenopathy, and 1 point for subcutaneous edema. Abscesses and adjacent arterial or venous thrombosis were also recorded by the readers because these factors were noted in the reference study but are not incorporated in the NSTI scoring system. The presence or absence of these findings was recorded by each reader on an electronic spreadsheet during interpretation. The NSTI score was automatically calculated from their input and used for analysis. For anatomic areas of involvement, each reader recorded which fascial planes were involved and if involvement was unilateral or bilateral. Fascial planes included the genitals (penis, scrotum, vulva and labia [vulva and labia were grouped as one structure for this study]), perineum, ischiorectal fossa, buttock, thigh, abdominal wall, retroperitoneum, and intraperitoneal (i.e., pneumoperitoneum).

Demographic and clinical data were collected and included medical comorbidities including immunosuppressive states (e.g., diabetes, underlying malignancy, dialysis-dependent renal failure, HIV status) and body mass index (BMI [weight in kilograms divided by height in meters squared]). The *t* test and chi-square were used to compare differences in male and female patients. Statistical significance was set at $p < 0.05$. Agreement was assessed using

Cohen kappa for categoric variables and the intraclass correlation coefficient (ICC) for NSTI score. Kappa values less than 0 as were considered no agreement; 0–0.20, slight agreement; 0.21–0.40, fair agreement; 0.41–0.60, moderate agreement; 0.61–0.80, substantial agreement; and 0.81–1, almost perfect agreement.

Results

Demographic data and differences between male and female patients are summarized in Table 1. The mean BMI was 42 (median, 37). Twenty-two (58%) patients had diabetes mellitus, four (11%) patients had an underlying malignancy, two (5%) patients had end-stage renal disease requiring hemodialysis, and no patients were positive for HIV. Female patients had a significantly higher mean BMI than male patients (46 vs 36, $p = 0.047$) and a significantly higher proportion of female patients had diabetes compared with male patients (16/21 [76%] vs 6/17 [38%]; $p = 0.01$).

The frequency of CT findings and interobserver agreement are highlighted in Table 2. Four of the five components of the NSTI CT scoring system showed almost perfect ($\kappa > 0.81$) or substantial ($\kappa = 0.61$ –0.80) agreement; lymphadenopathy had the lowest interobserver reliability with fair agreement ($\kappa = 0.37$). Subcutaneous edema was the most frequent finding for both readers, present in all 38 patients (100%). Fascial air was the second most frequent finding and present in nearly all patients for both readers (36/38 [95%], reader 1; 36/38 [95%], reader 2). Abscesses were relatively infrequent (nine cases [24%], reader 1; eight cases [21%], reader 2), and there were no cases of vessel thrombosis.

The mean NSTI score was 12.4 for reader 1 (range, 7–15) and 11.0 for reader 2 (range, 4–15). Except one case for reader 2 with an absence of fascial gas, all other patients (38/38 [100%], reader 1 and 37/38 [97%], reader 2) met the proposed NSTI CT score threshold of 6 or greater for the diagnosis of necrotizing fasciitis. For each reader's two cases without fascial air, the NSTI scores were 7 and 10 for reader 1 and 4 and 10 for reader 2. In the one patient with the NSTI score that did not meet the threshold of 6 or greater, both readers agreed there was no fascial air, reader 1 interpreted that all other four NSTI findings were present, whereas reader 2 detected only fluid tracking and subcutaneous edema. The overall NSTI reader agreement (i.e., agreement on all five categories) was only slight ($\kappa = 0.16$); however, when separating the NSTI score in quartiles given a minimum score of 4 and a maximum score of 15 (i.e., NSTI scores of 4–6, 7–9, 10–12, 13–15) or when allowing an error margin of ± 2 points, agreement was substantial ($\kappa = 0.68$; $\kappa = 0.68$).

Anatomic areas of involvement are summarized in Table 3. Both genital (33/38 [87%], reader 1; 32/38 [84%], reader 2) and perineal (33/38 [87%], reader 1; 32/38 [84%], reader 2) involvement were the most commonly involved anatomic areas overall. Genital involvement was present in nearly all female patients (20/21 [95%], both readers 1 and 2) and most male patients (13/17 [76%], reader 1; 12/17 [71%], reader 2). Spread to adjacent fascial planes was most frequently to the buttock (22/38 [58%], reader 1; 10/38 [26%], reader 2) and thighs (20/38 [53%], reader 1; 18/38 [47%], reader 2) (Figs. 1–3). Retroperitoneal spread was infrequent (3/38 [8%], reader 1; 6/38 [16%], reader 2) and there were no cases of intraperitoneal spread (i.e., pneumoperitoneum) for either reader.

Discussion

In the current study, CT manifestations of FG included fascial air in a high proportion of patients, with most CT findings of necrotizing fasciitis showing substantial or better interobserver reliability; the study cohort was composed of obese patients with a high proportion of female patients compared with prior reports. There have been few imaging cohorts of patients with FG that report specific findings associated with the disease and, at the time of writing, the present series is the largest imaging cohort of FG. Wysoki et al. [8] reported a retrospective cohort of CT findings of 20 patients with pathology-proven necrotizing fasciitis, including 10 cases on the FG spectrum—six with a scrotal source and four with a perineal source. In these 10 patients with genitourinary necrotizing fasciitis, CT showed fascial thickening in all 10 (100%), soft-tissue gas in eight (80%), and associated abscesses in five (50%). Villanueva Rincón et al. [9] reported a retrospective series of five patients with FG and at least two CT studies. Gas was seen in the scrotum in five of five patients and in the perineum in four of five patients. There are other small FG CT series with fewer patients [10, 11], and larger CT cohorts of necrotizing fasciitis that have fewer than five patients with FG [16] or that do not specify the anatomic distribution of necrotizing fasciitis [17]. Several surgical series offer statements that imaging was used selectively in patients with FG, but most do not report how frequently or infrequently CT or any imaging technique was used [12–14]. One exception is Oguz et al. [3]: They reported the frequency of using CT (8/43 patients [19%]) but did not report the individual CT findings. Two small cohorts of ultrasound findings in six [18] and three [19] patients with FG have been reported; all nine patients in both had sonographic findings of soft-tissue gas. Only case reports of MRI findings associated with FG have been reported [20–22]. Schmid et al. [23] reported MRI characteristics of 17 patients with necrotizing fasciitis, including four with infection spread to the pelvic fascia; however, they did not report any details of those four patients.

McGillicuddy et al. [4] proposed the NSTI CT score that was used in the current study. Their study consisted of a retrospective review of 305 patients admitted to a single center for suspected soft-tissue infections at any anatomic site (i.e., not specific to FG) who underwent CT to assess for necrotizing fasciitis. Forty-four of the 305 (14.4%) patients had surgical or culture-proven necrotizing soft-tissue infections. They reported 15 of 44 patients with necrotizing fasciitis with a genitourinary source of infection and another four of 44 patients with a perianal source of infection, but they did not report specific CT findings for this subset of patients (rather, the study reported the overall CT findings in all 44 patients) and they did not specify which of these patients were on the FG spectrum [4]. CT findings significantly associated with necrotizing soft-tissue infections when compared with the 261 patients without necrotizing fasciitis included fascial air, muscle or fascial edema, fluid tracking, lymphadenopathy, and subcutaneous edema. Assigning numeric scores to these CT findings, they developed the NSTI CT scoring system where a cumulative score of 6 or greater was suggestive of necrotizing fasciitis based on their data. The NSTI score is supported in our series: All cases of FG except one case for one reader (38 patients [100%], reader 1 and 37 patients [97%], reader 2) showed NSTI scores at or above the threshold score of 6; however, we should note that there were no control subjects in the current study.

Moreover, we found that four of the five findings described in the NSTI scoring system showed substantial to almost perfect interobserver reliability. Although a perfect match NSTI score with agreement in all five categories showed only slight interreader agreement ($\kappa = 0.16$), allowing slight variability between NSTI score (i.e., ± 2 points) showed substantial agreement ($\kappa = 0.68$).

Our series showed a higher proportion of female patients (21 of 38 patients; 55%) with FG than has been reported; the proportion of female patients in FG series typically range from 3% to 21% [1–3]. The anatomic areas of involvement were notably similar for male and female patients when considering the study definition of FG. Furthermore, the female patients in our series had a significantly higher mean BMI compared with male counterparts. Although this discrepancy to previous reports may reflect the increasing incidence of obesity in women in the United States [24], longitudinal data comparing BMI and sex incidence with FG along with modern data from other centers are needed to support a rising incidence of FG in women. The current study from a single center is not sufficiently designed or powered to assess the incidence of FG in female patients.

There are limitations to the current study including its retrospective nature, lack of control group, search criteria, and few patients without CT evidence of fascial air. A control group of patients with cellulitis or soft-tissue pelvic infection but without FG would have established sensitivity and specificity. We chose to identify patients with FG from an operative database rather than a radiology information search to include all patients with surgically proven FG. Our study design failed to include patients who did not undergo surgery or who were incorrectly diagnosed with FG by an interpreting radiologist. However, maintaining a reference standard of operative proof of FG was our main reason for excluding these cases. An additional consideration with using the NSTI scoring system was to see if it could identify patients with FG without the CT finding of fascial air; however, there were so few patients with operatively proven FG without fascial air (two patients [5%], reader 1; two patients [5%], reader 2) that we were unable to validate or refute this. Future studies could include multiple institutions to increase the frequency of patients with FG without fascial air. A difficult task for radiologists in practice is diagnosing FG without the CT finding of fascial gas. Our study design did not establish the interreader agreement or variability in diagnosing FG; rather, it catalogued the described CT findings in patients with known FG. Applying the reference NSTI CT scoring system [4] used in the current study in a prospective manner would be a useful study design, because it may capture patients with cellulitis or soft-tissue infection that does not progress to necrotizing fasciitis. The current study was designed to report the CT findings and anatomic areas of involvement in a cohort of patients with surgically proven FG. Followup studies that correlate CT findings of FG with outcomes and comparing patients with FG who underwent CT in the course of their admission compared with those who did not would better define the usefulness of preoperative CT studies of FG in clinical practice. Although the mean BMI of the female patients was significantly higher than that of the male patients in the current study, our analysis did not account for population differences because the distribution and magnitude of obesity in women differs from men [24, 25]. A notable point from the present series is the overall cohort was obese with a mean BMI of 42 (median, 37).

In conclusion, we report the frequency of CT findings, anatomic areas of involvement, and interobserver reliability of CT findings in 38 patients with surgically proven FG. Our series showed a higher proportion of female patients with FG than has previously been reported. Fascial air was present in nearly all of the patients in our study (95%). CT findings of FG are reproducible with substantial to almost perfect interobserver reliability for nearly all CT findings with the exception of lymphadenopathy. Anatomic areas of involvement can be extensive, and preoperative CT delineation of all fascial planes can potentially help plan the surgical approach.

References

1. Eke N Fournier's gangrene: a review of 1726 cases. *Br J Surg* 2000; 87:718–728 [PubMed: 10848848]
2. Gürdal M, Yücebas E, Tekin A, Beysel M, Aslan R, Sengör F. Predisposing factors and treatment outcome in Fournier's gangrene: analysis of 28 cases. *Urol Int* 2003; 70:286–290 [PubMed: 12740493]
3. Oguz A, Gümmü M, Turkoglu A, et al. Fournier's gangrene: a summary of 10 years of clinical experience. *Int Surg* 2015; 100:934–941 [PubMed: 25859652]
4. McGillicuddy EA, Lischuk AW, Schuster KM, et al. Development of a computed tomography: based scoring system for necrotizing soft-tissue infections. *J Trauma* 2011; 70:894–899 [PubMed: 21610394]
5. Wong CH, Khin LW, Heng KS, Tan KC, Low CO. The LRINEC (Laboratory Risk Indicator for Necrotizing Fasciitis) score: a tool for distinguishing necrotizing fasciitis from other soft tissue infections. *Crit Care Med* 2004; 32:1535–1541 [PubMed: 15241098]
6. Corcoran AT, Smaldone MC, Gibbons EP, Walsh TJ, Davies BJ. Validation of the Fournier's gangrene severity index in a large contemporary series. *J Urol* 2008; 180:944–948 [PubMed: 18635215]
7. Laor E, Palmer LS, Tolia BM, Reid RE, Winter HI. Outcome prediction in patients with Fournier's gangrene. *J Urol* 1995; 154:89–92 [PubMed: 7776464]
8. Wysoki MG, Santora TA, Shah RM, Friedman AC. Necrotizing fasciitis: CT characteristics. *Radiology* 1997; 203:859–863 [PubMed: 9169717]
9. Villanueva Rincón JM, Pérez Nevado A, Vicente Catalán L, Marcos Sánchez F, Arbol Linde F, Milanés Nivia B. CT in Fournier's gangrene (in Spanish). *Arch Esp Urol* 1998; 51:873–880 [PubMed: 9887560]
10. Park BJ, Sung DJ, Yeom SK, et al. Communication between spaces formed by fasciae of male external genitalia and perineum: computed tomographic cadaveric study and clinical significance. *J Comput Assist Tomogr* 2010; 34:193–198 [PubMed: 20351502]
11. Amendola MA, Casillas J, Joseph R, Antun R, Galindez O. Fournier's gangrene: CT findings. *Abdom Imaging* 1994; 19:471–474 [PubMed: 7950832]
12. Ersay A, Yilmaz G, Akgun Y, Celik Y. Factors affecting mortality of Fournier's gangrene: review of 70 patients. *ANZ J Surg* 2007; 77:43–48 [PubMed: 17295820]
13. Basoglu M, Ozbey I, Atamanalp SS, et al. Management of Fournier's gangrene: review of 45 cases. *Surg Today* 2007; 37:558–563 [PubMed: 17593474]
14. Koukouras D, Kallidonis P, Panagopoulos C, et al. Fournier's gangrene, a urologic and surgical emergency: presentation of a multi-institutional experience with 45 cases. *Urol Int* 2011; 86:167–172 [PubMed: 21212627]
15. Smith GL, Bunker CB, Dinneen MD. Fournier's gangrene. *Br J Urol* 1998; 81:347–355 [PubMed: 9523650]
16. Zacharias N, Velmahos GC, Salama A, et al. Diagnosis of necrotizing soft tissue infections by computed tomography. *Arch Surg* 2010; 145:452–455 [PubMed: 20479343]

17. Leichtle SW, Tung L, Khan M, Inaba K, Demetriades D. The role of radiologic evaluation in necrotizing soft tissue infections. *J Trauma Acute Care Surg* 2016; 81:921–924 [PubMed: 27602893]
18. Morrison D, Blaivas M, Lyon M. Emergency diagnosis of Fournier's gangrene with bedside ultrasound. *Am J Emerg Med* 2005; 23:544–547 [PubMed: 16032628]
19. Andipa E, Liberopoulos K, Asvestis C. Magnetic resonance imaging and ultrasound evaluation of penile and testicular masses. *World J Urol* 2004; 22:382–391 [PubMed: 15300391]
20. Yoneda A, Fujita F, Tokai H, et al. MRI can determine the adequate area for débridement in the case of Fournier's gangrene. *Int Surg* 2010; 95:76–79 [PubMed: 20480846]
21. Kickuth R, Adams S, Kirchner J, Pastor J, Simon S, Liermann D. Magnetic resonance imaging in the diagnosis of Fournier's gangrene. *Eur Radiol* 2001; 11:787–790 [PubMed: 11372608]
22. Okizuka H, Sugimura K, Yoshizako T. Fournier's gangrene: diagnosis based on MR findings. *AJR* 1992; 158:1173–1174
23. Schmid MR, Kossmann T, Duewell S. Differentiation of necrotizing fasciitis and cellulitis using MR imaging. *AJR* 1998; 170:615–620 [PubMed: 9490940]
24. Flegal KM, Kruszon-Moran D, Carroll MD, Fryar CD, Ogden CL. Trends in obesity among adults in the United States, 2005 to 2014. *JAMA* 2016; 315:2284–2291 [PubMed: 27272580]
25. Williamson DF. Descriptive epidemiology of body weight and weight change in U.S. adults. *Ann Intern Med* 1993; 119:646–649 [PubMed: 8363190]

Fig. 1—

49-year-old man with locally invasive rectal adenocarcinoma to sphincter complex and prostate who was undergoing chemoradiation and presented with rectal fluctuance. CT was performed to assess extent of clinically suspected perirectal abscess; Fournier gangrene was not clinically suspected. **A–C**, Sequential axial contrast-enhanced CT images show perirectal abscess (*thin arrows*, **A** and **B**) and tract of gas along right perineum and scrotum (*thick arrows*, **A** and **B**) with gas surrounding right testicle (*arrow*, **C**). At surgery, perirectal abscess due to rectal perforation was confirmed as well as necrotizing fasciitis involving perineum and scrotum. Patient underwent extensive serial débridements of perirectum, perineum, and scrotum and required diverting colostomy. Both study readers concurred with findings of fascial air, fascial edema, fluid tracking, and subcutaneous edema in keeping with necrotizing soft-tissue infection score of 13.

A

Fig. 2—

84-year-old morbidly obese woman with diabetes who presented with hyperglycemia, leukocytosis, and right groin ulcerative wound with foul discharge on physical examination. **A**, CT scout image shows patient's habitus as well as soft-tissue air about right groin and thigh (*arrow*).

B–D, Sequential axial contrast-enhanced CT images show fascial air involving right labia, perineum, and thigh (*thin arrows*) along with extensive subcutaneous fat and muscle edema about right thigh (*thick arrows*).

E, Sagittal CT reconstruction image centered to right of midline shows extent of dominant tract of fascial air (*arrows*), which extends into lower anterior abdominal wall. Patient underwent extensive surgical débridement of lower abdominal wall, labia, perineum, and right thigh, where Fournier gangrene was confirmed. Patient died shortly after surgical

débridement. Both study readers concurred with findings of fascial air, fascial edema, and subcutaneous edema in keeping with necrotizing soft-tissue infection score of 10.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

A

Fig. 3—

84-year-old obese woman with diabetes who presented with leukocytosis and painful buttock boil clinically evident on left gluteal cleft.

A, CT scout image shows patient's habitus as well as soft-tissue air about perineum extending along left abdominal wall subcutaneous fat (*arrows*).

B–D, Axial contrast-enhanced CT images show fascial air involving left buttock, perineum, and labia (*thin arrows*, **B** and **C**) extending cranially about mons pubis into left anterior abdominal wall (*arrows*, **D**). Areas of soft-tissue edema (*thick arrow*, **B**) are evident as well. Fournier gangrene was confirmed at surgery, which included extensive débridement of left buttock, perineum, radical left vulvectomy, and anterior abdominal wall. Both study readers concurred with findings of fascial air, fascial edema, and subcutaneous edema in keeping with necrotizing soft-tissue infection score of 10.

Characteristics and Necrotizing Soft-Tissue Infection (NSTI) Scores of Study Group With Surgically Confirmed Fournier Gangrene: Comparisons by Sex

TABLE 1:

Characteristic	Total	Male Patients	Female Patients	<i>p</i> (Male vs Female Patients)
Patients, no. (%)	38	17 (45)	21 (55)	0.47
Age (y), mean	52	47	56	0.18
BMI				0.047 ^a
Mean	42	36	46	
Median	37	32	41	
Diabetes, no. (%)	22 (58)	6 (35)	16 (76)	0.01 ^a
Mean NSTI score				
Reader 1	12.4	12.3	12.5	0.77
Reader 2	11.0	10.8	11.3	0.51

Note—BMI = body mass index (weight in kilograms divided by height in meters squared).

^aStatistically significant at the $p < 0.05$ level.

TABLE 2:
Interobserver Reliability and Incidence of CT Findings in the Necrotizing Soft-Tissue Infection (NSTI) Scoring System

CT Finding	Our Definition	No. of Points for NSTI CT Scoring System	κ	Incidence (<i>n</i> = 38), No. (%) of Patients	
				Reader 1	Reader 2
Fascial air	Locules or tracts of air attenuation through fascial planes	5	0.90	36 (95)	36 (95)
Muscle or fascial edema	Thickening or indistinctness of fascial surface or muscle; asymmetric appearance compared with contralateral side, if applicable	4	0.63	38 (100)	31 (82)
Fluid tracking	More-defined collection of fluid dissecting through soft-tissue planes, more fluid than would be accounted for by edema	3	0.68	15 (39)	12 (32)
Lymphadenopathy	Prominence of regional lymph nodes, asymmetric to the contralateral side when applicable; no specific size threshold was used	2	0.37	28 (74)	22 (58)
Subcutaneous edema	Edema underlying an area of thickened skin	1	1.00	38 (100)	38 (100)
Thrombosis	Filling defect in regional artery or vein	Not scored	1.00	0	0
Abscess	Organized rim-enhancing fluid collection; no size threshold was used	Not scored	0.95	9 (24)	8 (21)

Note—The definitions and criteria listed here are our criteria and definitions (i.e., these definitions and criteria were not adapted from the reference study [4]).

TABLE 3:

CT Areas of Anatomic Involvement for Both Study Radiologists, Readers 1 and 2

Anatomic Area of Involvement	κ^a	Incidence, No. (%) of Patients							
		Total (n = 38)				Male Patients (n = 17)			
		Reader 1	Reader 2	Reader 1	Reader 2	Reader 1	Reader 2	Reader 1	Reader 2
Genitals	Calculated individually	33 (87)	32 (84)	13 (76)	12 (71)	20 (95)	20 (95)	20 (95)	20 (95)
Penis	0.29	8 (47)	9 (53)	8 (47)	9 (53)	—	—	—	—
Scrotum	0.65	13 (76)	12 (71)	13 (76)	12 (71)	—	—	—	—
Vulva and labia	0.91	21 (100)	20 (95)	—	—	21 (100)	20 (95)	20 (95)	20 (95)
Perineum	0.68	33 (87)	32 (84)	15 (88)	15 (88)	18 (86)	17 (81)	17 (81)	17 (81)
Ischiorectal fossa	0.80	12 (32)	10 (26)	7 (41)	6 (35)	5 (24)	4 (19)	4 (19)	4 (19)
Buttock	0.32	22 (58)	10 (26)	8 (47)	6 (35)	14 (67)	4 (19)	4 (19)	4 (19)
Thigh	0.47	20 (53)	18 (47)	8 (47)	6 (35)	12 (57)	11 (52)	11 (52)	11 (52)
Abdominal wall	0.68	14 (37)	19 (50)	5 (29)	8 (47)	9 (43)	11 (52)	11 (52)	11 (52)
Retroperitoneum	0.74	3 (8)	6 (16)	2 (12)	2 (12)	1 (5)	4 (19)	4 (19)	4 (19)
Intraperitoneal (pneumoperitoneum)	1.00	0	0	0	0	0	0	0	0
Bilateral disease (any area) ^b	Not calculated	22 (58)	23 (61)	10 (59)	12 (71)	12 (57)	11 (65)	11 (65)	11 (65)
> 2 Fascial compartments ^c	Not calculated	26 (68)	26 (68)	10 (59)	12 (71)	16 (76)	14 (67)	14 (67)	14 (67)

Note—Dash (—) indicates not applicable.

^aKappa value for overall agreement (i.e., both male and female patients).^bThese data were reported individually by the reader for each anatomic area of involvement.^cThis observation was a secondary observation that was not specifically scored by the readers.