CLINICAL ORTHOPAEDICS AND RELATED RESEARCH
Number 399, pp. 265–271

Correlating Selection Criteria With Subsequent Performance as Residents

Douglas R. Dirschl, MD; Laurence E. Dahners, MD*; George L. Adams, BA**; John H. Crouch, MS*; and Frank C. Wilson, MD**

The objective of this study was to determine which criteria in the residency application had the highest correlation with subsequent performance of orthopaedic residents. Data collected from the application files of 58 residents included scores on standardized tests, number of honors grades in the basic and clinical years of medical school, election to Alpha Omega Alpha, numbers of research projects and publications, and numbers of extracurricular activities. Measures of performance included scores on the Orthopaedic In-Training Examination and American Board of Orthopaedic Surgery Part I Examination, and faculty evaluations of overall, cognitive, affective, and psychomotor performance. The number of honors grades on clinical rotations was the strongest predictor of performance, whereas election to Alpha Omega Alpha was second. The only other significant correlation was between the number of fine motor activities and psychomotor performance. None of the predictor variables had a significant correlation with Orthopaedic In-Training Examination or American Board of Orthopaedic Surgery Examination scores. Consistency between faculty rankings in each of the four categories was supported by regression analysis. From the results of this study, it appears that academic performance in clinical clerkships in medical school is the most predictive of resident performance. Range restriction in the data available for orthopaedic residency applicants, however, likely precludes the development of a reliable model to assist in the selection of orthopaedic residents.

From the *University of North Carolina School of Medicine, Wake Medical Education Institute, Raleigh, NC; and from **East Carolina University School of Medicine, NC.

Reprint requests to Douglas R. Dirschl, MD, Department of Orthopaedics, University of Oregon Health Sciences Center, 3181 SW Sam Jackson Park Road, Portland, OR 97201.

Each residency training program must have a method for determining which applicants it most desires to recruit, and selecting residents is one of the most demanding yet crucial responsibilities for medical faculty. In some training programs, applicant rankings are established by a predetermined formula, but in most programs, applicants' files are analyzed on a subjective basis by members of an admissions committee, who then reach a consensus ranking of the candidates. Ideally, each admissions committee should assess data from its own program to determine how well the criteria for resident selection predict outcomes important to the program, such as the residents' subsequent performance on faculty evaluations or the residents' scores on accreditation examinations.

Several prior studies have examined the residency application process, most of them

assessing residency program directors' opinions as to the most important criteria in selecting a resident.[1,2,3,6] Only one prior study has attempted to correlate data in the residency application with subsequent performance in a training program.[4] That study, in an internal medicine program, concluded that the scoring of residents' applications correlated only moderately with final evaluation scores at the completion of training. In addition, the only application variables correlating with final evaluation scores were honors in an internal medicine clerkship and graduation from the medical school at which the residency training program was located. The authors concluded that the intern selection committee overemphasized the predictive value of election to Alpha Omega Alpha, scores on the National Board of Medical Examiners Examination, Part 1, and medical school reputation.

The assessment of physicians has three dimensions: cognitive, affective, and psychomotor. These three domains are especially applicable to surgical training programs, where residents perform in and are assessed continually in each of these domains. Using these domains as a base, an analysis was conducted of the resident selection process at a university-based orthopaedic residency program. The purpose of this study was to determine which criteria in the residency application had the highest correlation with the subsequent performance of orthopaedic residents.

METHODS

The residency application files for all residents who trained in the orthopaedic residency program at the University of North Carolina at Chapel Hill from 1983 to 1997 were considered for this study. Sixty-six residency applications were identified that met these criteria. Application files were entered in the study if the resident had successfully completed the training program and if complete residency application data were available. Six residents left the training program before completion during the study period, transferring to other orthopaedic training programs (three residents) or to training programs in others specialties (three residents). Two residents did not have complete residency application data available. Thus, 58 orthopaedic residency application files met the criteria for entry in the investigation. Of the 58 residents entered in the investigation, four were female and four were Asian-American. Additionally, eight had received their medical degree from the University of North Carolina School of Medicine, and three had done externships in the training program. To maintain confidentiality of the information in these files, only the most junior investigator and the statistician, neither of whom had any connection with the University of North Carolina School of Medicine or the orthopaedic training program, had access to the raw data.

The information obtained from the application files included scores on standardized tests, measures of academic achievement and skill, and subjective measures (Table 1). Test scores included the numeric sum score on the Scholastic Aptitude Test, the numeric sum score on the Medical College Admissions Test, and the percentile ranking on the United States Medical Licensing Exam, Part I, or National Board of Medical Examiners, Part I. Because of a change in the scoring system for the Medical College Admissions Test during the period which this study ranged, 12 Medical College Admissions Test scores had to be converted from the new scoring system to the old scoring system. Because not all medical schools required students to take the United States Medical Licensing Exam, Part I or the National Board of Medical Examiners, Part I, only 36 of the 58 resident applicants had these scores available.

Measures of academic achievement included the number of honors grades in Anatomy, Physiology, Biochemistry, Pathology, Microbiology, and Pharmacology; and the number of honors grades in core clinical clerkships, which included Surgery, Internal Medicine, Pediatrics, Obstetrics and Gynecology, and Psychiatry. Additional measures of academic achievement included election to Alpha Omega Alpha, the number of research projects in which the applicant had been involved, the number of research abstracts published, and the number of manuscripts published.

Potential predictors of motor skill and leadership also were abstracted from each application. On the residency application, residents were asked to list hobbies and interests, volunteer activities, and leadership activities. Because of the retrospective nature of this study, only skills or activities volun-

TABLE 1. Variable Evaluated as Predictors of Resident Performance

Scores on Standardized Tests	
Scholastic Aptitude Test	
Medical College Admissions Test	
United States Medical Licensing Exam, Part I or National Board of Medical Examiners, Part I	
Measures of Academic Achievement	
Honors 1	Number of honors in core courses, medical school Years 1 and 2
Honors 2	Number of honors in core courses, medical school Years 3 and 4
Alpha Omega Alpha	Election to Alpha Omega Alpha
Research	Number of research projects
Abstracts	Number of abstracts published
Publications	Number of manuscripts published
Measures of Skill	
Gross motor	Number of activities using gross motor skills
Fine motor	Number of activities using fine motor skills
Leader	Number of leadership roles
Volunteer	Number of volunteer activities
Subjective Measures	
Letters	Mean rating of three letters of recommendation

teered by the applicants could be scored. The number of activities that involved gross motor skills was recorded (athletics, carpentry, automobile repair), as were the number of activities that entailed fine motor skills (playing a musical instrument, painting, woodworking). The numbers of leadership roles and volunteer activities of the applicants also were recorded.

As a subjective measure, three letters of recommendation for each applicant were rated: a letter from a chairman or chief of orthopaedics, a letter from another orthopaedist, and a letter from a nonorthopaedic physician. Each letter of recommendation was masked by removing any mention of the applicant's name, the author's name, or the author's institution. Thus, letters of recommendation were rated on the content of the letter only, with the reviewer having no knowledge of the applicant's name, the author's name, or the author's institution. Three faculty members rated each letter of recommendation as outstanding, average, or poor. The score recorded for each letter was the mean of the three faculty ratings.

Outcome measures of resident performance included performance on the Orthopaedic In-Training Examination, performance on the American Board of Orthopaedic Surgery Part I Examination, and four composite faculty ratings (Table 2). The Orthopaedic In-Training Examination was taken by each resident during each year of his or her training. Each resident's score on this examination was reported as a percentile score compared with scores of other residents in the country in the same year of residency education. The score for the Orthopaedic In-Training Examination used in this study was the mean of the percentile scores for all the examinations a given resident had taken. In addition, for each applicant, the percentile score on the American Board of Orthopaedic Surgery Part I Examination was recorded.

Faculty ratings were performed by six orthopaedic faculty members who had been members of

TABLE 2. Outcome Measures

Performance on Examinations	
Orthopaedic In-Training Examination	
American Board of Orthopaedic Surgery Part I Examination	
Faculty Grading	
Overall	Mean of six faculty ratings
Cognitive	Mean of six faculty ratings
Affective	Mean of six faculty ratings
Psychomotor	Mean of six faculty ratings

the training program for the entire 15 years during which the residents in the study had trained. The six faculty graded each resident in four categories: overall performance, cognitive skill, affective performance, and psychomotor skill. It was postulated that cognitive rating would relate most closely to academic ability, psychomotor skills to manual dexterity, and affective performance to integrity, commitment, and professionalism.

The four faculty ratings were done at different times, at least 2 months apart, in an effort to exclude any halo effect. The faculty assigned grades of A, B, C, D, or F for each area, and for the overall grade. This grading scale, which has been used previously, has been shown to be acceptable for studies such as this one.[5] The grades were assigned numerical values (A = 4, B = 3, C = 2, D = 1, and F = 0) and the mean of the six faculty grades was reported for each resident.

Stepwise linear regression analysis of the mean faculty ratings was done to determine the relationship of predictor variables to outcomes. The stepwise linear regression analysis added variables one by one, provided the F statistic was significant (< 0.05) to enter the model. Once a new variable was added, the procedure evaluated all variables and removed variables that were no longer significant (< 0.05 or < 0.15; see Results). The outcome of the regression analysis was a group of variables predictive of the outcome measure at a selected level of significance.

A regression also was calculated using cognitive, motor, and affective ratings, and the Orthopaedic In-Training Examination score, as predictors of the overall grade. The purpose of this analysis was to test the consistency between faculty ratings in the individual domains and the overall rating.

RESULTS

Consistency between the faculty rankings in each of the four components within the overall grade was supported by linear regression analysis, which showed that the cognitive, psychomotor, and affective skills were significant in predicting the overall grade ($p < 0.01$ and $R^2 = 0.86$). The Orthopaedic In-Training Examination score, however, was not a useful predictor of overall ranking ($p > 0.5$). Because the residents in this study trained during a 15-year period, it is possible that the performance of more recent graduates may be more memorable to faculty raters, either positively or negatively, than the performance of earlier graduates would be. To assess this possibility, an analysis was done of residents in the top 15% in overall faculty rating and those in the bottom 15% in overall faculty rating. It was found that both groups of residents were distributed evenly throughout the study; this seems to indicate that memory bias on the part of the faculty is unlikely.

Using a threshold for statistical significance of $p < 0.05$, the results of the stepwise linear regression analysis are listed in Table 3. The number of honors grades in the core clinical clerkships in the third and fourth years of medical school correlated with each of the faculty ratings. In addition, the number of fine motor activities and manuscripts published correlated with psychomotor outcome. The only predictor that correlated with performance on the Orthopaedic In-Training Examination was the score on the Scholastic Aptitude Test. None of the predictor variables correlated with performance on the American Board of Orthopaedic Surgery Part I Examination at this level of statistical significance. Scores on the Orthopaedic In-Training Examination ranged from the eighth to the one-hun-

TABLE 3. Correlation of Outcome Measures With Predictors

Outcome Variable	Significant Predictors ($p < 0.05$)
Overall	Honors 2
Cognitive	Honors 2
Affective	Honors 2
Psychomotor	Honors 2, publications, fine motor
Orthopaedic In-Training Examination	Scholastic Aptitude Test
American Board of Orthopaedic Surgery Part I Examination	none

(Stepwise Linear Regression Analysis).

dredth percentile, whereas scores on the American Board of Orthopaedic Surgery Part I Examination ranged from the fifth to the ninety-ninth percentile.

When the requirement for statistical significance was relaxed to $p < 0.15$, additional variables were found to be predictive of outcome (Table 4). The most significant addition to the model was that election to Alpha Omega Alpha became significant in predicting overall rating, cognitive skill, and performance on the Orthopaedic In-Training Examination. None of the predictor variables had a correlation at this level of significance with performance on the American Board of Orthopaedic Surgery Part I Examination.

The faculty's rating of the three letters of recommendation had a poor correlation with all of the outcome variables ($p > 0.5$).

An analysis of the eight residents in the study who had received their medical degree from the University of North Carolina School of Medicine revealed no significant differences in the information in their applications or in outcome measures from the remainder of the study group. One of these eight residents left the training program to pursue training in anesthesiology at the same institution. Because of the small number of residents (three) who had done externships in the training program while they were medical students, no analysis of this subgroup was done.

Although outcome data were not available for the six residents who did not complete the training program, analysis of the information available in the residency applications revealed no significant differences in any of the information collected from the 58 residents in the study group.

An analysis also was done of the final rankings of residency applicants submitted by the program to the National Residency Matching Program. For the 58 residents included in this study, the mean rank of residents when matching to the training program was 17 (range, 1–53). For residents in the top 15% in overall faculty rating (Table 2), the mean rank when matching to the program was 8 (range, 1–32). For residents in the bottom 15% in overall faculty rating (Table 2), the mean rank when matching to the program was 20 (range, 9–53). For the eight residents who had received their medical degree from the University of North Carolina School of Medicine, the mean rank when matching to the program was 14 (range, 4–31). For the six residents who did not complete the training program during the study period, the mean rank when matching to the program was 21 (range, 4–53).

TABLE 4. Correlation of Outcome Measures with Predictors

Outcome Variable	Significant Predictors ($p < 0.15$)
Overall	Honors 2, Alpha Omega Alpha, fine motor
Cognitive	Honors, 2, Alpha Omega Alpha, leadership
Affective	Honors 2
Psychomotor	Honors 2, publications, fine motor
Orthopaedic In-Training Examination	Scholastic Aptitude Test, Alpha Omega Alpha, research, abstracts
American Board of Orthopaedic Surgery Part I Examination	None

(Stepwise Linear Regression Analysis).

DISCUSSION

From the results of this study, it appears that academic performance in clinical clerkships in medical school is most predictive of subsequent overall performance as an orthopaedic resident. Election to Alpha Omega Alpha is moderately predictive of resident performance, and participation in many activities involving fine motor skills is slightly predictive of psychomotor performance. The other variables investigated are far less predictive.

Outcome measures that involved grading by the faculty showed remarkable internal

consistency in this study. Cognitive, motor, and affective grades correlated highly with overall performance ($p < 0.01$), which indicates that the faculty rating of overall resident performance is sufficient to characterize resident performance. Additional faculty ratings in the cognitive, motor, and affective realms do not appear necessary to adequately characterize resident performance. Being in the top 15% in overall faculty rating was correlated with having had a higher ranking from the program in the national residency match than the rest of the study group. There was no difference in rankings from the program in the national residency match for the overall study group, those in the bottom 15% in overall faculty rating, and those who left the program before completion.

Although there was good internal consistency of faculty ratings in this study, there was little correlation of faculty ratings with percentile scores on the Orthopaedic In-Training Examination or American Board of Orthopaedic Surgery Part I Examination. In addition, the predictors studied also correlated poorly with Orthopaedic In-Training Examination and American Board of Orthopaedic Surgery Part I Examination scores. Thus, from the results of this investigation, scores on the Orthopaedic In-Training Examination and American Board of Orthopaedic Surgery Part I Examination may not be good measures of the outcome of residency training.

Letters of recommendation were poorly predictive of residents' performance, perhaps because there were no standards for assessment of the content of the letters of recommendation. Attempts were made to define such standards, but the faculty were unable to agree on criteria to use in rating letters of recommendation. These results also might be explained by the fact that letters were rated on content alone whereas, in the usual situation, the contents of a letter of recommendation often are not given as much weight as the author and the institution from which the letter was generated.

It would be highly desirable for residency programs to develop regression models by which data in the residency application could be used to predict resident performance at the end of training. One difficulty inherent in attempting to formulate such models is the issue of range restriction of the data. Because the residents accepted into the residency program presumably represent only a portion of the upper tail of a normal distribution for each of the predictor variables, the resultant narrow range of the predictor variables provides a smaller range for estimation than a random selection of applicants, resulting in a less reliable model. This limitation has been identified previously in a study attempting to define a selection model for medical school applicants.[7]

The phenomenon of range restriction also suggests a plausible explanation for the observed weak correlations of predictor variables to outcome variables seen in this study. The University of North Carolina Department of Orthopaedics receives 400 to 600 applications for residency each year, but only approximately the top 60 applicants are invited for an interview and ranked. A random distribution of applicants, however, would be necessary to establish a reliable model to predict outcomes from resident application data. It is doubtful that any orthopaedic residency program would seek to improve the predictive measure of its resident selection model by randomly admitting candidates to the residency program.

The number of variables that may be important as selection criteria for residents is vast and no investigation of the residency selection process in one training program can include every variable thought to be important by every residency program director or orthopaedic faculty member. For example, variables such as gender, race other than white, advanced degrees other than Doctor of Medicine, and performance of a clerkship at the training program may be important predictors of performance in residency; unfortunately, the numbers of applicants fitting these criteria in this study were too small for analysis. Performance on the United States Medical Licensing Exam, Part II, another measure of

cognitive skill, might be an important predictor of performance as a resident; results of this examination, however, are generally not available at the time of residency application and the purpose of this study was to correlate information from the residency application with subsequent performance as residents. Performance on the American Board of Orthopaedic Surgery Part II Examination also might be an important outcome measure, because the nature and content of this examination changed substantially during the course of the study and because only a pass or fail score is reported, the results of this examination were not included in this investigation.

The authors do not recommend that selection committees ignore data other than clinical grades in medical school in the evaluation and rating of resident applicants. For instance, the authors suspect that an adverse letter of recommendation may be strongly predictive of a poor outcome, but no applicants with adverse letters of recommendation were accepted into this training program. Although academic success is easiest to evaluate, professional behavior and psychomotor skills are also essential to success in orthopaedic surgery. Application reviews that rely on academic achievement alone may favor candidates lacking other essentials for successful performance.

The concerns over range restriction likely indicate that, short of random admission of applicants, attempts to derive regression models predictive of resident performance likely will meet with failure. Although it is not possible to completely objectify the process of resident selection, training programs can and should look carefully at how they select residents to gain useful information and insight. Based on the results of this study, orthopaedic residency programs should define what they value in a resident and develop a consistent method for analyzing and scoring objective and subjective data based on a set of criteria or values. The authors hope the results of this study may assist residency training programs in determining how to weight certain data in the resident application in developing criteria or values for resident selection in their own programs.

References

1. Baker JD, Bailey MK, Brahen NH, et al: Selection of anesthesiology residents. Acad Med 68:161–163, 1993.
2. Davis JL, Platt LD, Sandhu M, et al: Evaluating factors in the selection of residents. Acad Med 70:176–177, 1995.
3. DeLisa JA, Jain SS, Campagnolo DI: Factors used by physical medicine and rehabilitation residency training directors to select their residents. Am J Phys Med Rehabil 73:152–156, 1994.
4. Fine PL, Hayward RA: Do the criteria of resident selection committees predict residents' performances? Acad Med 70:834–838, 1995.
5. Mawhinney BS: Comparison of pre- and post-medical school entrance examination results. Br J Med Educ 8:49–51, 1974.
6. Taylor CA, Weinstein L, Mayhew HE: The process of resident selection: A view from the residency director's desk. Obstet Gynecol 85:299–303, 1995.
7. Weiss M, Lotan I, Kedar N, et al: Selecting candidates for medical school: An evaluation of a selection model based on cognitive and personality predictors. Med Educ 22:492–497, 1988.

Continuation of ORP Conference from page 252.

PATHOLOGIC FINDINGS

Multiple, irregular, pink fragments of firm tissue were evaluated that felt gritty when sectioned. Histologically, the lesion was composed of haphazardly arranged spindle-shaped stellate myofibroblasts (Fig 5A, open arrowhead) proliferating in an abundant loose connective tissue stroma. The myofibroblasts infiltrated the surrounding muscle (Fig 5A, black arrowhead). Multiple foci of osseous metaplasia (Fig 5A, arrow) were scattered throughout the lesion. In these areas, there were irregular trabeculae of osteoid, rimmed by plump osteoblasts (Fig 5B, arrow). The osteoblasts had eccentric vesicular nuclei, prominent nucleoli, and basophilic cytoplasm. Occasional osteoclasts were present. Small cartilaginous foci also were observed. The myofibroblasts varied in size and shape with a slightly basophilic, abundant cytoplasm and plump ovoid nuclei (Fig 5B, arrowhead). The cellular borders were indistinct (Fig 5C). No atypical mitoses were seen. The diagnosis was ossifying fasciitis.

DISCUSSION

A diagnosis of ossifying fasciitis was made in this case. Because the patient's pain and limited motion resolved subsequent to the biopsy, no additional surgery was done. He resumed all activities, without limitation. At 2.5 years after the biopsy, the patient was seen again subsequent to another episode of trauma. No mass was palpable in the thigh. Radiographs showed no evidence of the mass. Radiographic resolution of a similar lesion has been reported.[19]

Ossifying fasciitis is a benign reactive lesion and is a variant of the more commonly known entity nodular fasciitis. It has been reported in the literature under several names, including pseudosarcomatous fibromatosis,[1] fasciitis ossificans,[11] and, when it is adjacent to bone, parosteal fasciitis.[6] Among reported cases, ossifying fasciitis most commonly occurs in patients in the second decade of life, with a slight female predominance.[19] It primarily occurs in the extremities.

The etiology of ossifying fasciitis is understood poorly. There has been no consistent history of antecedent trauma or infection; however, in the current patient the authors observed that he had multiple episodes of trauma before the onset of symptoms. Daroca et a1[4] also described a case of ossifying fasciitis that occurred along the adventitia of the femoral artery at the site of a previous angiographic study.

Radiographically, ossifying fasciitis shows soft tissue swelling, variable periosteal reaction, and soft tissue calcification. The underlying cortex is intact.[14] Histologically, ossifying fasciitis appears as a well-circumscribed nodule in the subcutaneous or deep fascial fibroconnective tissue[15] and has areas typical of nodular fasciitis with associated formation of metaplastic bone. The salient feature is haphazardly arranged myofibroblastic proliferation in a myxoid or collagenous matrix. The fibroblasts have various forms with varying degrees of cellular atypia. Mitosis may be frequent. Irregular osteoid and woven bone with osteoblastic rimming and cartilage formation are present. Multinucleated giant cells also may be seen. The typical zoning pattern of myositis ossificans is not observed. Although the infiltrative growth pattern of ossifying fasciitis and the presence of foci of osseous and cartilaginous metaplasia may lead to misinterpretation of the entity as a more aggressive lesion, simple excision is adequate for fasciitis in any location. A review of reported cases elicited no cases of local recurrence after excision.

Ossifying fasciitis may mimic extraskeletal and parosteal osteosarcoma, radiographically, clinically, and/or histologically. It is of paramount importance to clearly distinguish this lesion from a malignant process. Extraskeletal osteosarcoma, comprising less than 5% of all osteosarcomas, typically effects an older population with 94% of patients older than 30 years.[8,10] It most commonly arises in the thigh.[8]

Although a history of trauma is reported in 12% to 31% of patients, there is no clear relationship to antecedent trauma.[10] The patient's symptoms are of varying duration. Cheung and Enzinger[3] reported symptoms greater than 2 years in only 19% of patients. Radiographically, the lesion is calcified in approximately 50% of patients and rarely involves adjacent bone.[8] Histologically, extraskeletal osteosarcoma frequently shows classic malignant features, with areas of necrosis and atypical nuclei, and may show a "reverse zoning phenomenon."[8] There frequently is infiltration of adjacent soft tissues. The prognosis of patients with extraskeletal osteosarcoma is poor with 5-year survival less than 25%, and median survival of 24 months.[8] However, Yi et al[20] reported a patient with low-grade extraskeletal osteosarcoma with no evidence of recurrence at 25 months.

Somewhat more common than extraskeletal osteosarcoma,[12,13] parosteal osteosarcoma also presents as an enlarging, ossified mass in the soft tissues.[2] It typically occurs in older patients than those with conventional (central) osteosarcoma.[7,12] As in extraskeletal osteosarcoma, there also is no consistent history of trauma.[13] With the indolent growth pattern of this lesion, the patients present with a slowly enlarging mass, frequently present for greater than 1 year.[13] This lesion arises from either the periosteum or periosteal connective tissue.[12] It is in direct continuity with, and tends to encircle, the bony cortex. It occurs most frequently at the posterior aspect of the distal femoral metaphysis.[7,13,16,17] Histologically, these lesions usually are low grade[7,13,17,18] and have spindle cells with rare mitoses and abundant osteoid. Increased cellularity is seen at the periphery. Approximately 16% have a dedifferentiated pattern. The treatment for patients with the more common low-grade lesion is wide surgical resection with a 5-year survival in the range of 90%.[13,18]

Myositis ossificans is another entity that may be confused with ossifying fasciitis. It is a benign condition characterized by reactive ectopic bone in muscle. Sixty percent to 75% of patients with myositis ossificans have a history of trauma. Radiographically, almost always a readily definable lucent zone between cortex and the soft tissue ossification is seen, especially on CT scans. There is a peripheral rim of ossification and a central area with decreased attenuation on CT scans. Mature lesions have more diffuse ossification.[9] Microscopically, myositis ossificans generally is characterized by the presence of a distinct zonal pattern that reflects different degrees of cellular maturity, the presence of immature cellular areas in the center, and more mature ossifying areas at the periphery.[5] Ossifying fasciitis lacks this type of zonal maturation as was seen in the current patient.

Ossifying fasciitis is a self-limited benign process that may simulate a malignant neoplasm in its clinical, radiographic, or histologic appearance and may cause diagnostic difficulties. However, an awareness of its histologic features, including an absence of necrosis and lack of atypical mitoses, and predilection for presenting as a rapidly enlarging mass, should decrease the likelihood of misdiagnosis and the risk of overly aggressive treatment.

Acknowledgment

The authors thank Jan Brunks for help with preparation of this manuscript.

References

1. Angervall L, Stener B, Stener I, Ahrer C: Pseudomalignant osseous tumor of soft tissue: A clinical, radiological and pathological study of five cases. J Bone Joint Surg 51B:654–663, 1969.
2. Chang CP, Chu YK, Chu LS, et al: Scintigraphic appearance of parosteal osteosarcoma. Clin Nucl Med 22:54–56, 1997.
3. Cheung EB, Enzinger FM: Extraskeletal osteosarcoma. Cancer 60:1132–1142, 1987.
4. Daroca PJ, Pulitzer DR, Locicreo J: Ossifying fasciitis. Arch Pathol Lab Med 106:682–685, 1982.
5. Enzinger FM, Weiss SW: Osseous Soft Tissue Tumors. In Enzinger FM, Weiss SW (eds). Soft Tissue Tumors. Ed 3. St Louis, CV Mosby 1013–1014, 1995.
6. Hutter RVP, Foote FW, Francis KC, Higinbotham N: Parosteal fasciitis: A self-limited benign process that stimulates a malignant neoplasm. Am J Surg 104:800–807, 1962.
7. Huvos AG: Juxtacortical Osteogenic Sarcoma. In Huvos AG (ed). Bone Tumors Diagnosis, Treatment

and Prognosis. Ed 2. Philadelphia, WB Saunders 157–175, 1979.
8. Jensen ML, Schumacher B, Jensen OM, Nielsen OS, Keller J: Extraskeletal osteosarcomas: A clinicopathologic study of 25 cases. Am J Surg Pathol 22:588–594, 1998.
9. Krandsdorf MJ, Murphey MD: Imaging of Soft Tissue Tumors. Philadelphia, WB Saunders 3l7–325, 1997.
10. Krandsdorf MJ, Murphey MD: Imaging of Soft Tissue Tumors. Philadelphia, WB Saunders 333–335, 1997.
11. Kwittken J, Branche M: Fasciitis ossificans. Am J Clin Pathol 51:251–256, 1969.
12. Lindner N, Ozaki T, Hillmann A, Blasius S, Winkelmann W: Adjuvant local treatment of parosteal osteosarcoma. Int Orthop (SICOT) 20:233–236, 1996.
13. Okada K, Frassica FJ, Sim FH, et al: Parosteal osteosarcoma: A clinicopathological study. J Bone Joint Surg 76A:366–378, 1994.
14. Porter AR, Tristan TA, Rudy FR, Eshback TB: Florid reactive periostitis of the phalanges. Am J Roentgenol 144:617–618, 1985.
15. Price SK, Kkahan LD, Saxe N: Dermal and intravascular fasciitis: Unusual variants of nodular fasciitis. Am J Dermatopathol 15:539–543, 1993.
16. Raymond AK: Surface osteosarcoma. Clin Orthop 270:140–147, 1991.
17. Ritschl P, Wurnigh C, Lechner G, Roessner A: Parosteal osteosarcoma: 2–23 year follow-up of 33 patients. Acta Orthop Scand 62:195–200, 1991.
18. Sheth DS, Yasko AW, Raymond AK, et al: Conventional and dedifferentiated parosteal osteosarcoma: Diagnosis, treatment, and outcome. Cancer 78:2136–2145, 1996.
19. Spjut HJ, Dorfman HD: Florid reactive periostitis of the tubular bones of the hands and feet: A benign lesion which may simulate osteosarcoma. Am J Surg Pathol 5:423–433, 1982.
20. Yi ES, Schmookler BM, Malawer MM, Sweet DE: Well-differentiated extraskeletal osteosarcoma: A soft-tissue homologue of parosteal osteosarcoma. Arch Pathol Lab Med 115:906–909, 1991.