

An Investigation Into Differential Diagnosis of Pulp and Periapical Pain: A PennEndo Database Study

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Abstract

Nine hundred fifty-one emergency and 997 nonemergency patients seeking endodontic treatment were the basis of this study. Variables of interest were 10 pain descriptors, percussion and palpation tests, causative factors, and paired pulpal and periapical diagnoses. A higher number of patients suffering from symptomatic pulpal conditions sought emergency care. Odds of caries being a causative factor were high in symptomatic pulps compared with asymptomatic pulpal and periapical conditions. Higher odds ratios were obtained for sharp pain in symptomatic pulps versus symptomatic periapical conditions. Conversely, odds ratios for dull pain were higher in symptomatic periapical conditions compared with asymptomatic periapical conditions. Percussion and palpation tests were significant in differentially diagnosing between pulpal and periapical conditions. In conclusion, caries was associated with painful pulpitis. The results confirm the differential diagnostic power of sharp and dull pain and percussion and palpation tests. Several symptoms previously believed to have differential diagnostic power were found insignificant. (*J Endod* 2007;33:548–551)

Keywords:

Acute apical abscess, acute apical periodontitis, dental pain, differential diagnosis, irreversible pulpitis, pain descriptors, pulpal and periapical diagnosis

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Diagnostic accuracy, which refers to the ability of a test to discriminate between subjects with and without disease, is commonly measured by using sensitivity and specificity. When a standard diagnostic test can be used as a gold standard, determining the accuracy rates of other tests can be easily performed. Unfortunately, in pulpal diagnosis, a standard is not available to determine the accuracy of other tests. This is because no consistent relationship has been found between clinical symptoms and histopathologic conditions of the pulp (1–4). Patients experiencing identical clinical symptoms may exhibit different histologic appearances of the involved pulp. The only condition that can be diagnosed with certainty is pulp necrosis. Therefore, the clinician is forced to make a clinical diagnosis by using the patient's history and description of pain, clinical examination, and various diagnostic tests.

Traditionally, descriptors of pain and other signs and symptoms have been empirically used as part of pulpal and periapical diagnosis (5–8). A few studies have investigated the association of signs and symptoms with clinical pulpal and periapical diagnoses (3, 9). However, these studies either did not use advanced statistical analyses or studied small patient populations. Clearer insight into these associations might help us discover which signs and symptoms have a potential for improving differential diagnosis and treatment quality in pulpal and periapical diseases.

The purpose of this study is to use a logistic regression model to determine any associations between signs and symptoms and different pulpal and periapical diagnoses in a large patient population.

Materials and Methods

From 2000 to 2004, endodontic residents at the University of Pennsylvania recorded their endodontic case diagnoses in an electronic database consisting of 4,853 patients. This database contains, along with periapical and pulpal diagnoses, information regarding patients' pain symptoms at the time of diagnosis (binary variables for intermittent, provoked, throbbing, lingering, spontaneous, radiating, dull, sharp, localized, and diffused pain), results of clinical evaluations (palpation and percussion), primary location of pain (tooth number), causative factors, and an indicator variable for whether the case was an emergency or not. Logistic regression models were fit to these data by using the binary pain symptoms as outcomes and paired diagnoses as the primary predictor variable, controlling for emergency cases and tooth type (anterior and posterior teeth). From these models, odds ratios for presence of each specified pain response at all possible pairs of diagnosis levels were generated. The significance of these odds ratios was determined by asymptotic theory; confidence intervals were calculated at 95% levels, corresponding to 0.05 significance levels. Regression models and all analyses performed in this study were done in the statistical package R (<http://www.r-project.org>).

From the full database, records used for the study were selected on the basis of whether the patient indicated pain at the time of treatment. Within this subset of 2,439 records, there were 31 levels of paired diagnoses including those with missing values either at the pulpal or periapical levels or both. Those entries with missing diagnoses were removed for estimation purposes. In addition, it was seen that several diagnoses achieved low counts (<5 cases) when the data were tabulated, and these diagnoses were removed. The data cleanup resulted in 13 levels of paired diagnoses, with 1,948 observations, 951 emergency and 997 nonemergency cases.

The 13 levels of diagnoses resulted in 13 levels of the main predictor variable in consideration (Table 1). This meant that odds ratios generated as described earlier

TABLE 1. Diagnostic Groups for Pulpal and Periapical Diagnosis

Pulpal diagnosis	
Symptomatic pulpal (SPU)	Symptomatic irreversible pulpitis
Asymptomatic pulpal (APU)	Asymptomatic irreversible pulpitis Previous root canal treatment Pulp necrosis
Periapical diagnosis	
Symptomatic periapical (SPE)	Primary acute apical abscess Secondary acute apical abscess Acute apical periodontitis
Asymptomatic periapical (APE)	Within normal limits* Chronic apical periodontitis

*Absence of swelling and normal response to percussion and palpation tests.

would produce 13 × 13 tables for each of the 10 pain characters that would not have been easily interpretable. For purposes of practical interpretation as well as more robust estimation, these diagnoses were collapsed into “symptomatic” and “asymptomatic” diagnoses; thus, from 13 levels of the main predictor variable, it was possible to reduce the dimension to the following four levels.

1. Symptomatic diagnosis at both the pulpal and periapical levels (SPU.SPE/symptomatic pulp and periapical). It is essentially a combination of acute pulpitis and acute apical periodontitis.
2. Asymptomatic pulpal diagnosis with an asymptomatic periapical diagnosis (APU.APE/or asymptomatic pulp and periapical). Its equivalents can range from an operative carious exposure to chronic apical periodontitis (Table 1).
3. Symptomatic pulpal with asymptomatic periapical (SPU.APE/symptomatic pulpal). It can be considered equivalent to acute pulpitis or irreversible pulpitis.
4. Asymptomatic pulpal with symptomatic periapical (APU.SPE/symptomatic periapical). It is basically equivalent to acute apical periodontitis or acute apical abscess.

Teeth were diagnosed as “symptomatic pulps” when they exhibited spontaneous pain or episodes of pain to temperature changes that outlasted the stimulus. Similarly, teeth diagnosed as “symptomatic periapical” exhibited painful response to percussion and/or palpation tests or intraoral/ extraoral swelling.

Results

Among emergency and nonemergency patients, 60.0% of root canal treatments were the result of caries, 18.4% faulty restorations, 12.9% posttreatment apical periodontitis, 3.1% trauma, 3.1% fracture, and 1.0% idiopathic. Many patients had multiple etiologies recorded. Because caries was the main cause for root canal treatment, further analysis was performed to determine its relationship to diagnoses. The odds of caries being the etiologic factor when the patient was diagnosed with symptomatic pulpal or symptomatic pulpal and periapical was about 4 times greater than for a similar patient diagnosed with asymptomatic pulpal and periapical or symptomatic periapical ($p < 0.05$) (Table 2).

TABLE 2. Odds Ratios for the Presence of Caries Between Diagnoses

	APU.APE	SPU.APE	APU.SPE	SPU.SPE
Caries				
APU.APE	1.000	0.245*	1.062	0.271*
SPU.APE	4.086*	1.000	4.341*	1.106
APU.SPE	0.941	0.230*	1.000	0.255*
SPU.SPE	3.693*	0.904	3.923*	1.000

*Significant at the 0.05 level.

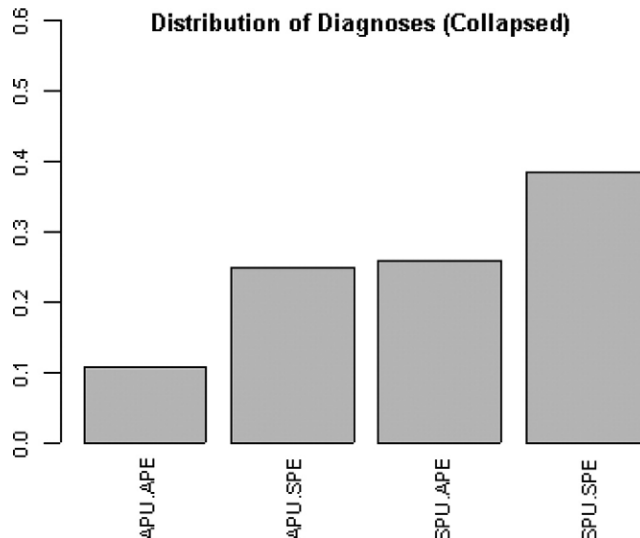


Figure 1. Distribution of diagnoses in combined emergency and nonemergency patients.

In the combined data, there were 38.5% symptomatic pulpal and periapical, 25.8% symptomatic periapical, 24.9% symptomatic pulpal, and 10.7% asymptomatic pulpal and periapical (Fig. 1). When the distribution was analyzed separately, a slightly higher percentage of asymptomatic pulpal and periapical and symptomatic periapical was found in nonemergency cases, whereas the percentage of symptomatic pulpal and periapical and symptomatic pulpal was found to be higher in emergency patients (Fig. 2).

Ten different pain characters were used to determine any significant association with the four types of endodontic diagnoses. Statistically significant results were only obtained with sharp, dull, and lingering pain (Table 3). The odds of having observed a sharp pain when the patient has been diagnosed with symptomatic pulpal and periapical and symptomatic pulpal are 3.3 and 3.8 times greater, respectively, than for

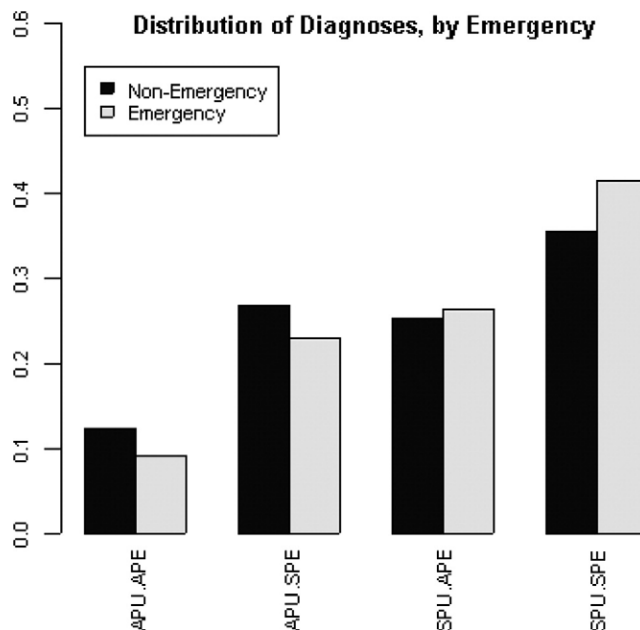


Figure 2. A comparison of diagnoses between emergency and nonemergency patients

TABLE 3. Odds Ratios for Pain Descriptors Between Diagnoses

	APU.APE	SPU.APE	APU.SPE	SPU.SPE
Dull				
APU.APE	1.000	3.608*	1.067	2.872*
SPU.APE	0.277*	1.000	0.296*	0.796
APU.SPE	0.937	3.380*	1.000	2.691*
SPU.SPE	0.348*	1.256	0.372*	1.000
Sharp				
APU.APE	1.000	0.218*	0.840	0.252*
SPU.APE	4.577*	1.000	3.845*	1.154
APU.SPE	1.190	0.260*	1.000	0.300*
SPU.SPE	3.965*	0.866	3.331*	1.000
Lingering				
APU.APE	1.000	0.575*	0.896	1.084
SPU.APE	1.740*	1.000	1.559	1.887
APU.SPE	1.116	0.641	1.000	1.210
SPU.SPE	0.922	0.530	0.826	1.000

*Significant at the 0.05 level.

a similar patient diagnosed with symptomatic periapical ($p < 0.05$). The odds of having observed a dull pain when the patient is diagnosed with symptomatic periapical were about 3.4 and 2.7 times greater than for a similar patient diagnosed with symptomatic pulpal and periapical or symptomatic pulpal, respectively ($p < 0.05$). Other pain descriptors such as intermittent, provoked, radiating, spontaneous, throbbing, localized, and diffused did not show any significance with endodontic diagnoses.

Additional results were produced for percussion and palpation tests to determine any association with final diagnoses (Tables 4 and 5). The odds ratios were based on the event of observing a more severe response in palpation and percussion tests; note that it was the direction of response that was of interest here, rather than the event of observing a discrete response, as before. For a patient with symptomatic pulpal and periapical, the odds of more severe palpation and percussion responses were 6.4 and 29.4 times greater than the same odds for a similar patient with symptomatic pulpal, respectively ($p < 0.05$). For a patient with symptomatic periapical, the odds of more severe palpation and percussion responses were 19.9 and 48.0 times greater than for a similar patient with symptomatic pulpal, respectively ($p < 0.05$).

Discussion

Pulpal and periapical diseases constitute important groups of conditions, but there is no universal agreement about the delineation and classification of these disorders (10–13). In this study, when large

TABLE 4. Odds Ratios for Palpation Response

	APU. APE	SPU. APE	APU. SPE	SPU. SPE
Palpation				
APU. APE	1.000	5.711*	0.287*	0.892
SPU. APE	0.175*	1.000	0.050*	0.156*
APU. SPE	3.482*	19.884*	1.000	3.105
SPU. SPE	1.121	6.403*	0.322	1.000

*Significant at the 0.05 level.

TABLE 5. Odds Ratios for Percussion Response

	APU. APE	SPU. APE	APU. SPE	SPU. SPE
Percussion				
APU. APE	1.000	10.572*	0.220*	0.359*
SPU. APE	0.095*	1.000	0.021*	0.034*
APU. SPE	4.539*	47.985*	1.000	1.631
SPU. SPE	2.783*	29.426*	0.613	1.000

*Significant at the 0.05 level.

numbers of diagnostic categories were used, only a small number of variables were able to achieve statistical significance. This was similar to previous investigators who found a poor correlation between clinical symptoms and histopathologic features when pulpal diagnosis was subdivided (4, 14). Because some of the diagnostic categories used measured similar aspects, the number of diagnosis was reduced to a manageable size.

The results of this study indicate that 60% of root canal treatments were caused by carious pulp exposures. On the other hand, only 18.5% of root canal treatments were necessitated because of restoration-related reasons. These results are in conformity with De Quadros et al. (15) and Serene and Spolsky (16).

It is also interesting to note that the odds of caries being the causative factor when the patient is diagnosed with symptomatic pulpal conditions is about four times greater than for a similar patient diagnosed with asymptomatic pulpal conditions. These results are supported by Bender (17) who reported a 79% incidence of carious pulp exposures in the presence of severe pulpal pain. This not only points toward a bacterial etiology of symptomatic pulpal conditions but also to the possibility that in differential diagnosis a tooth with a carious lesion is responsible for symptomatic pulpal conditions.

The most common reason for seeking root canal treatment in this cohort of patients is symptomatic pulpal and periapical diagnosis, followed by symptomatic pulpal with asymptomatic periapical diagnosis (Fig. 1). The results partly conform to Saad and Clem (18) who reported that necrotic pulp and irreversible pulpitis were the most frequent reasons for endodontic therapy in 382 patients studied at a post-graduate endodontic program. However, in our sample, almost 50% of the patients were derived from the emergency clinic.

A comparison of emergency and nonemergency patients also indicates that a relatively higher percentage of patients with symptomatic pulpal involvement seek emergency care (Fig. 2). A small number of patients with asymptomatic pulpal and periapical diagnosis also sought emergency treatment for reasons such as carious pulp exposure during operative procedures.

A look at the odds ratios generated for sharp pain indicates that sharp pain is primarily of pulpal origin (Table 3). One is four times more likely to have sharp pain from a symptomatic pulpal rather than symptomatic periapical condition. Statistically significant results involving sharp pain were obtained only in the presence of symptomatic pulpal conditions. On the other hand, dull pain followed an opposite pattern indicating that dull pain more commonly originates from periapical conditions. Laboratory and clinical findings indicate that sharp pain is primarily mediated by A-fibers, located in the dentine, whereas activation of C-fibers, located in pulp, contribute to the dull pain induced by pulpal inflammation (17, 19). In this study, the odds ratios for dull pain were 3 times greater in symptomatic periapical conditions compared with symptomatic pulpal condition, which indicates that dull pain is primarily periapical in origin.

The results for pain provoked by cold stimuli indicated the odds of having observed a lingering pain when the patient is diagnosed with asymptomatic pulpal and periapical diagnosis are 0.6 times less than for a similar patient diagnosed with symptomatic pulpal or asymptomatic periapical diagnosis ($p < 0.05$) (Table 3). These results reconfirm the usefulness of thermal tests in diagnosing symptomatic pulps.

Percussion and palpation tests were found extremely powerful in discriminating between pulpal and periapical conditions. The odds ratios for percussion and palpation were high in symptomatic periapical conditions when compared with symptomatic pulpal conditions. The results also show that the odds ratios for percussion and palpation are considerably reduced in the presence of pulpal vitality (Tables 4 and 5).

It is interesting to note that Klausen et al. (9), who with 92 patients classified pulpal and periapical diagnoses quite comparable to ours, were not able to distinguish between pulpoperiodontitis (symptomatic pulpal and periapical) and pulpitis (symptomatic pulpal) on the basis of symptoms and signs included in their investigation. However, they found the palpation test in the apical region to be significant in discriminating between pulpitis (symptomatic pulpal) and apical periodontitis (symptomatic periapical). Nusstein and Beck (20) also reported similar findings in a total of 323 patients.

Several symptoms previously believed to have differential diagnostic power were found insignificant. Pain descriptors, such as intermittent, provoked, radiating, spontaneous, throbbing, localized, and diffused, did not show any significant correlations with the endodontic diagnoses. This was either because of an even distribution of these variables in different diagnostic groups or because of their rare occurrence in the material. Klausen et al. (9) also noted insignificance relative to diagnoses with a number of symptoms, such as spontaneous pain, constant or intermittent pain, character of pain (sharp, dull, throbbing, and irradiating), and duration of pain. These results underscore the assumption that although pain descriptors remain useful and are perhaps necessary diagnostic tools, pain descriptors themselves cannot make the diagnosis alone. However, to keep things in proper perspective, it must be remembered that this study tested the significance of these pain descriptors in differential diagnosis of four uniquely grouped pulpal and periapical diagnostic categories. These pain descriptors still remain invaluable in differentiating between reversible and irreversible pulpitis. This aspect of pain descriptors was not investigated in this article.

It is possible that the odds ratios for variables may have been overestimated because of bias. It could be a problem of circularity; for example, if the percussion test is the gold standard for diagnosing symptomatic periapical condition, and the clinician's diagnosis is based, at least in part, on the results of this test, then this test will predominate the diagnostic group. Such an apparently circular procedure represents a limitation but is unavoidable in this type of study because of the absence of a true "gold standard."

In conclusion, caries was more likely associated with symptomatic pulpal conditions and the main causative factor for root canal treatments. A higher percentage of patients with painful pulpal conditions seek emergency care. Sharp pain was more likely associated with pulpal pathology, whereas dull pain was more likely associated with periapical

pathology. Percussion and palpation tests were powerful in differentially diagnosing between pulpal and periapical conditions. Under the conditions of this study, several symptoms previously believed to have differential diagnostic power were found insignificant.

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