

A prospective survey of percutaneous injuries in orthodontists

Robert A. Bagramian, DDS, MPH, DrPH,^a and James A. McNamara, Jr, DDS, PhD^b

Ann Arbor, Mich.

This national survey provides documentation regarding typical orthodontic practice patterns in the United States, including the prevalence of percutaneous injuries. The sample reflects a similar geographic distribution of the population as a whole, with more practitioners located in areas with higher populations. Most practitioners in this sample were in solo full-time practice, averaging 35 hours per week, and treating patients for 47 weeks per year. A 20-day prospective period was used to collect data regarding exposure to percutaneous injuries. The study identified a mean percutaneous injury rate of 0.085 during a 20-day period for practicing orthodontists, a value that can be extrapolated to slightly less than one (0.99) percutaneous injury per orthodontist per year. The majority of these injuries (84%) occurred outside the mouth. This rate is approximately one third the rate reported for dentists in general practice. (*Am J Orthod Dentofacial Orthop* 1998;114:654-8)

The last two decades has seen an increased awareness of occupational injury among generalists and specialists in medicine and dentistry, an increase that has been due in part to the dramatic rise in HIV-positive patients as well as the recognition that hepatitis B is a bloodborne infection with potentially lethal consequences to the health care provider.^{1,2} With an increased understanding of the potential danger posed to dental practitioners routinely exposed to patient's blood and other body fluids, the Centers for Disease Control (CDC) conducted a number of studies focused on the risk of transmission between infected patient and provider³⁻⁵ and later from infected provider to patient,⁶ establishing guidelines for universal precautions to be taken during the treatment of dental patients.

In 1986, the American Dental Association surveyed its membership regarding the knowledge of, compliance with, and attitudes toward infection control procedures and treatment of HIV-positive patients, a survey that was repeated in 1988.⁷ These surveys noted an increasing acceptance of hepatitis B vaccine among dentists and an increasing use of gloves and other barrier techniques during dental procedures. By 1988, only 2% of respondents reported not using gloves, a change in practice protocol due in great part to an increasing aware-

ness of the AIDS epidemic. Further, a surveillance study conducted by the CDC⁸⁻¹⁰ revealed that the likelihood of a health care worker becoming infected as a result of exposure to contaminated blood was very low (0.3%), with a percutaneous injury the most likely pathway to transmit a bloodborne pathogen such as HIV.

Other surveys of practicing dentists were conducted by the ADA at the annual sessions of that organization.¹¹ These voluntary self-reports by dentists participating in the Health Screening Program in 1987 to 1991 indicated that the rates of percutaneous injury were about 3.5 injuries per year, a number that did not differ substantially from the number of injuries per year reported by members of the ADA who completed a survey, but who did not participate in the screening program (2.7 injuries per year). In 1992, Siew et al¹¹ combined the results for the 1986 and 1988 ADA surveys with those from the health screening participants. The results of this analysis indicated that dentists experienced an annual injury rate of 3.21; general dentists have a slightly lower rate (3.16) than specialists (3.43). Oral and maxillofacial surgeons (4.62) and pediatric dentists (4.13) had the highest rates of all specialists, whereas endodontists had the fewest percutaneous injuries. Concerns were raised, however, regarding whether those responding were representative of practicing dentists as a whole and whether selective memory was the basis of their reports, as data were gathered retrospectively.

Thus, the American Dental Association commissioned a randomized, prospective study to determine the exact nature and frequency of percutaneous injury experiences in routine dental practice.¹² Over 6000 members and nonmembers of the ADA were selected from the ADA's national sample frame of dentists in private practice, representing about 3.5% of all dentists in the United States.¹² These practitioners were asked

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^aProfessor of Dentistry, Department of Periodontics, Prevention and Geriatrics, School of Dentistry; Professor of Dental Public Health, Department of Epidemiology, School of Public Health, The University of Michigan.

^bProfessor of Dentistry, Department of Orthodontics and Pediatric Dentistry; Professor of Anatomy and Cell Biology; and Research Scientist, Center for Human Growth and Development, University of Michigan; in private practice, Ann Arbor, Mich.

Reprint requests to: Dr. James A. McNamara, Department of Orthodontics and Pediatric Dentistry, School of Dentistry, University of Michigan, Ann Arbor, MI 48109-1078; e-mail: mcnamara@umich.edu

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Table I. Object with which orthodontist was injured

Object	N	Percentage
Bur	2	5.3
Explorer	1	2.6
Rotary disk	2	5.3
Orthodontic wire	20	52.6
Scaler	4	10.5
Other sharp instrument	4	10.5
Other	5	13.2
Total injuries	38	100

to complete a series of demographic questions as well as maintain a daily work log for recording injuries that occurred during 20 consecutive practice days. For the purpose of this study, a percutaneous injury was defined as "any breach in the integrity of the skin of the dentist in the dental operator, regardless of whether or not bleeding resulted."¹² Those not responding to the request were sent two follow-up notices; the response rate was 42%, with over 2300 dentists completing the survey. Based on the number of working days (20), the total number of injuries reported, and assuming that the average dentist practices 48 weeks per year, Siew et al¹² estimated the annual percutaneous injury rate to be 3.4, a number similar to previous studies that used differing methods, including the observational study of Cleveland et al,¹³ who reported a rate of 3.6 injuries per dentist per year.

As these investigations dealt with needle sticks and injuries with rotary dental instruments, it was felt that a study directly related to orthodontic practice would be of value. In the delivery of routine orthodontic treatment, the injury risk presumably would be less, as the profession does not routinely use syringes or rotating cutting instruments. The 1995 ADA survey¹² was the first study to evaluate prospectively the occurrence of percutaneous injuries among orthodontists. Based on an overall sample of 2304 dentists that included 120 orthodontists, the ADA estimated that the annual rate of percutaneous injury to orthodontists to be 1.9, the second lowest frequency behind endodontists (1.3 injuries per year). Interestingly, in this study, pediatric dentists had the most frequent occurrence of percutaneous injury (5.5 per year); whereas prosthodontists experienced 4.5 injuries per year. Oral and maxillofacial surgeons reported 2.4 injuries per year, a rate much lower than the 4.6 per year from a previous study.¹¹

In light of the continuing concerns with transmission of infectious diseases and the inherent dangers to orthodontic practitioners and their staff, the House of Delegates of the American Association of Orthodontists authorized the gathering of information to determine the present risk of percutaneous injury and effec-

Table II. Procedure being performed when injury occurred

Procedure	N	Percentage
Arch wire change	22	57.9
Bracket placement	2	5.2
Retention	1	2.6
Laboratory procedure	8	21.1
Other	5	13.2
Total injuries	38	100

tively structure preventive programs to educate the profession about methods to reduce and eliminate exposure. The initial plans were to conduct a study that followed the pattern of the ADA 20-day prospective diary study.¹² In addition to orthodontists, it was decided that chairside assistants should be involved as well because of their susceptibility to percutaneous injury with their clinical contacts. Therefore, two customized assistant surveys also were sent to each orthodontic practice selected for inclusion.

MATERIAL AND METHODS

A stratified random sample of practicing orthodontists in the regions of the United States and Canada represented by the eight constituent societies of the American Association of Orthodontists (AAO) was used for this study. The sample was selected by identifying every third person who was an active, affiliate, or associate member of AAO. The target sample included 2800 orthodontists; two orthodontic chairside assistants from each office were asked to complete the survey as well. Each subject was mailed a letter explaining the study along with a precoded questionnaire that requested information on general practice characteristics such as demographics, area of practice, group or solo, right or left handedness, with a 20-day diary of hours and days worked, type of procedures, and time and location of injuries. Each office received two additional assistant questionnaires for chairside staff to complete.

Questionnaires were mailed with preaddressed and stamped return envelopes. One follow-up mailing was conducted for nonresponders. A total of 225 subjects were eliminated due to death, retirement, or other reasons. Returns included 449 valid orthodontist and 693 assistant questionnaires used in the analysis. The results for the chairside assistants are included in a separate report.¹⁴ The 449 valid questionnaires produced a 17% response rate for orthodontists.

The survey mailings were handled through the central offices of the AAO. A private statistical consulting group was used for receiving completed surveys, coding, verifying accuracy, entering the data, and completing preliminary statistical analyses.

Data were analyzed further with the SPSS statistical

Table III. Total hours worked in a 20-day period

Hours worked	Not injured		Injured orthodontists		Injury rate
	N	%	N	%	%
55-120	27	6.5	8	22.9	12.9
121-140	87	21.0	10	28.6	9.4
141-160	211	51.0	13	37.1	6.6
Over 161	89	21.5	4	11.4	7.3
	Mean	151.0 hours (N = 414)	146.1 hours (N = 35)		

Table IV. Number of patients treated during a 20-day period

Patients treated	Not injured		Injured orthodontists		Injury rate
	N	%	N	%	%
65-499	74	17.9	15	42.9	16.9
500-699	97	23.4	10	28.6	9.4
700-899	90	21.7	3	8.6	3.2
900-1100	78	18.8	5	14.3	6.0
1100+	75	18.1	2	5.7	2.6
	Mean	814.23 patients (N = 414)	589.86 patients (N = 35)		

Table V. Hours worked per week by orthodontist

Hours worked	Not injured		Injured orthodontists		Injury rate
	N	%	N	%	%
8 to 20	12	2.9	2	5.7	14.3
21 to 30	84	20.3	6	17.1	6.7
31 to 40	264	63.8	21	60.0	7.4
40+	54	13.0	6	17.1	10.0
Totals	414	100	35	99.9	

package to verify frequencies, means, standard errors, and statistical significance. *T* tests were used for examining significance among mean responses, and chi square was used to test for significance related to proportions and percentages of responses. Statistical significance was determined for those results having $P < .05$.

RESULTS

Injury Exposure Risk

The 20-day prospective period was used to examine the prevalence and risk of percutaneous injury. Thirty-five practitioners (7.8% of the sample) reported they received 38 percutaneous injuries. Thirty-two (7.1%) practitioners reported receiving 1 injury, and 3 (0.7%) reported receiving 2 injuries during the 20-day reporting period. Based on this sample of 449 orthodontists, the mean number of injuries per 20-day period was 0.085.

Sixteen percent of injuries occurred when procedures were being performed inside the mouth; 84% occurred elsewhere. The largest number of injuries (N

= 20, 52.6%) were associated with the manipulation of orthodontic wire (Table I). There were reports, however, of injuries from a variety of objects present in the office such as scalers (10.5%), rotary disks (5.3%), burs (5.3%), and explorers (2.6%). Scalers and other sharp instruments accounted for 21% of injuries.

Only one injury was reported on the arm, with the remaining 97% (N = 37) occurring on the finger or hand. Of these injuries, most occurred to the index finger (49%). The thumb was injured in 16% of cases, and the ring finger was the least injured with 8%.

Not surprisingly, the largest number of injuries, 57.9% (N = 22) occurred during the changing of arch wires, as this procedure was reported most frequently performed (Table II).

Practice Characteristics and Injuries

All parts of the United States and Canada (as indicated by the constituent societies of the AAO) were represented in the response. The largest response was in the Pacific Coast at 20%, followed by the Southern

Table VI. Mean number of patients seen per day

	Not injured (N = 414)	Injured (N = 35)
Average day	46.7	32.9*
Light day	34.1	22.8*
Heavy Day	60.1	45.0*

*Statistically significant at $P \leq .001$.

at 17%, and the Midwest with 15%. The smallest number of responders was from the Rocky Mountain area (5%), the component of the AAO with the fewest members. Injuries occurred equally in all regions.

Eighty-nine percent of orthodontists were right-handed, and the incidence of injuries reflected similar patterns between right-handedness and left-handedness. About 78% of the sample was in solo practice, and injuries occurred in similar patterns for group and solo practices.

Of the 38 injuries reported by 35 different orthodontists, 4 (11%) occurred on Monday, and the others were distributed equally on the remaining four days. Forty-two percent of the injuries occurred before noon.

The average hours worked during this period was 151, with a range of 55 to 220 hours. Fifty percent of the total sample reported working 141 to 160 hours (7 to 8 hours/day), and 21% reported working more than 160 hours (more than 8 hours per day). There was no statistical significance between reported working hours and injury rate (Table III).

The average number of patients seen during this period was 797, with a range of 65 to 2538. Injury rates were lower for those orthodontists treating more patients. Orthodontists reporting at least one injury during the-20 day period saw significantly fewer patients (589.9) on average than did those reporting no injuries (814.2), despite working a comparable number of hours ($P < .001$; Table IV). This finding also is evident in significant differences in patients per hour (injured = 3.9, not injured = 5.4; $P < .001$) and patients per day (injured = 29.5, not injured = 40.8; $P < .001$).

Most orthodontists reported working between 31 to 40 hours per week. Mean hours worked in a typical week were 35, with 64% of the sample reporting working between 31 to 40 hours. Only 3% reported working 8 to 20 hours. Mean weeks worked in a typical year were 47, with a high of 40% of orthodontists reporting they work 48 to 49 weeks. It is interesting to note that 16% stated they worked over 49 weeks per year, whereas a low of 5% reported working 9 to 40 weeks. Although not statistically significant, a slightly higher percentage of injuries occurred with those orthodontists who reported either working fewer than 20 hours or more than 40 hours per week. Fewer injuries occurred for those who worked between 21 to 40 hours (Table V).

Table VII. Mean percent time per task

Task	Not injured (N = 414)	Injured orthodontists (N = 35)
Examination/consultation	11.5%	10.2%
Diagnostics	4.1%	6.3%
Appliance placement/removal	17.4%	17.4%
Arch wire change	23.4%	24.4%
Application adjustment	22.7%	20.3%
Retainer check	8.4%	7.5%
Laboratory procedures	3.4%	4.5%
Administrative/clerical	9.1%	10.1%

There was no statistical significance between years in practice and style of assistant utilization. The longer in practice, however, the more frequently an orthodontist reported working with an assistant (i.e., four-handed dentistry). With more than 20-years experience in private practice, 42% of orthodontists worked with an assistant 95% to 100% of the time. On average, 73% of the time these orthodontists worked with an assistant. Only 19% of the sample reported working with an assistant less than half of the time.

Although not statistically significant, there was a trend for those who reported working with an assistant for greater amounts of time to have fewer injuries. Of those working with an assistant less than 75%, 11.2% reported injury, whereas 6.3% of those working 75% or more reported injury (Chi square: $\chi^2 = 3.07$, $P < .08$).

Fewer years in private practice and increased injuries showed statistical significance. Nineteen percent of those practicing 5 years or less reported an injury, whereas 7.2% were injured with 6 to 10 years of experience. Five percent of those practicing 11 to 20 years and 7% of those with more than 20 years experience reported injuries ($\chi^2 = 11.96$, $P < .008$).

Sixty-six percent of the sample stated that they saw 36 or more patients on an average day; 32% saw over 50 patients; and 6% saw over 75 patients a day. On a heavy day, 85% treated over 36 patients, whereas 57% saw over 50 patients, and 18% saw over 75 patients per day. Significantly, of those seeing 20 or fewer patients on an average day, 22.5% were injured, whereas only 11.6% of those seeing 21 to 35 patients, 5.2% of those seeing 36 to 50 patients, and 2.8% of those seeing more than 50 patients on an average day were injured ($\chi^2 = 21.13$, $P < .001$). Similar statistically significant patterns of a higher injury rate associated with fewer patients seen were found on light patient days ($\chi^2 = 12.24$, $P < .007$) and heavy patient days ($\chi^2 = 12.62$, $P < .006$) as well, so that, in general, more patients were treated by noninjured orthodontists compared with injured orthodontists under all conditions (Table VI).

The majority of time in practice was spent by the orthodontist changing arch wires (24%), whereas diagnostic record visits and laboratory procedures occupied

only 4% each of the orthodontist's time. Orthodontists injured spent similar percentages of time as noninjured orthodontists on all tasks except for an increased time on diagnostic records (Table VII).

The mean number of patients seen for specific procedures by both noninjured and injured orthodontists follows a similar pattern, with a high of 17 and 12 patients, respectively, seen per day for changing arch wires to a low of two patients, respectively, seen for the diagnostic records procedure. Injured dentists saw significantly fewer patients for examinations and consultations ($P < .001$), fewer for diagnostic records ($P < .05$), and fewer for arch wire change ($P < .05$).

DISCUSSION

The results of this study indicate that orthodontists have a rate of percutaneous injury that is low in relation to most other generalists and specialists in dentistry. During the 20-day period considered in this study, an average of 0.085 injuries occurred. Extrapolating this frequency to an annualized basis and using the present survey average of working 47 weeks per year, the typical orthodontic practitioner experiences less than one episode (0.99) of percutaneous injury each year. This rate is less than the 3.3 injuries per year of general dentists, and the 2.8 injuries per year of dental specialists.¹² The rate for orthodontists from the current study is less than the rate (1.9 injuries per year) for the 120 orthodontists identified in the 1995 ADA study.¹²

Although the exposure rate in this study generally is low, it should be noted that the majority of injuries (84%) occurred outside of the mouth. In the 1995 ADA study, 82% occurred extraorally during chairside procedures, clean-up, or lab work. If an injury occurs extraorally, the clinician can remove his or her gloves, wash, and reglove before touching the patient, thus minimizing exposure to the patient and to the clinician.

In the present study, the largest number of injuries was associated with the manipulation of arch wires, although burs, scalers, explorers, and rotary disks also were involved in some injuries. It should be noted that no syringe sticks were reported in the current study, a finding that is not surprising in that injections are not used routinely in orthodontic practice. In the 1995 ADA study,¹² the most common intraoral injuries were associated with syringes (32%) and sharp instruments (28%). Extraoral injuries predominantly were caused by burs (40%). The differences in the instruments and accessories used in orthodontic procedures may account for the lower incidence of percutaneous injuries in orthodontic practice in comparison to other types of dental practice.

Another finding was that percutaneous injury occurred during arch wire changes; the majority of injuries occurred to the index finger and thumb. With

this reported exposure to injury, the profession may choose to implement an educational program to inform practitioners of the risk of injury and the precautions that can be taken to reduce this risk.

SUMMARY

This national survey provides documentation with respect to typical orthodontic practice patterns in the United States and Canada including the prevalence of percutaneous injuries. Most practitioners in this sample were in solo full-time practice averaging 35 hours per week for 47 weeks per year treating patients. A 20-day prospective period was used to collect data regarding exposure to injuries. The study identified a mean percutaneous injury rate of 0.085 during a 20-day period for practicing orthodontists, an injury rate that can be extrapolated to slightly less than one (0.99) percutaneous injury per orthodontist per year. The majority of these injuries (84%) occurred outside the mouth. This rate was lower but somewhat comparable than the figure determined by a smaller sample of orthodontists from the 1995 survey of dentists conducted by the American Dental Association and three times as low as the rate reported previously for practicing dentists in general.

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