
2002 JCO Study of Orthodontic Diagnosis and Treatment Procedures

Part 1 Results and Trends

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The next several issues of JCO will present the results of the fourth JCO Study of Orthodontic Diagnosis and Treatment Procedures, previously conducted in 1986, 1990, and 1996. This month's article covers the basic results and compares them to those of past studies; future articles will break down the 2002 data into various categories.

Methodology

The 1996 Treatment Study questionnaire was revised based on past responses and on suggestions from JCO editors and orthodontic manufacturers regarding the latest materials and techniques. It was mailed on June 26, 2002, to 8,812 orthodontists, which represented virtually all the specialty practitioners in the United States. Of these, 789 questionnaires were returned, for a response rate of 9.0%. The size of the response and the consistency of answers and demographic data with previous JCO studies indicate to us that the results are valid.

The questionnaire responses were entered on computer by an independent company and analyzed with the Statistical Package for the Social Sciences. A few specific responses that

were obviously erroneous or out of range were excluded from calculations of those particular tables.

In this Study, the median, which is the middle number when all responses are ranked from highest to lowest, is often reported instead of the mean, which is the arithmetical average, because medians are less affected by extremely high or low responses. Means must be used when breaking down responses by category, as will be done later in this series of articles.

"NA" in a table indicates that a particular item was not included in that year's questionnaire. In many cases, respondents were asked to indicate whether they used a technique or appliance "occasionally" or "routinely". To make comparisons among the four studies easier to read, the "occasionally" responses have been omitted from this article. Complete tables of the 2002 results will be placed on the JCO website at www.jco-online.com.

Demographics

The current Study agreed with the JCO Orthodontic Practice Studies in showing a gradual aging of the orthodontic population and an

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**TABLE 1
DEMOGRAPHICS (MEDIANS)**

| | 2002 | 1996 | 1990 | 1986 |
|---|-------|-------|-------|-------|
| Age (years) | 49.0 | 48.0 | 45.0 | 44.1 |
| Sex | | | | |
| Male | 89.9% | 93.6% | 95.5% | NA |
| Female | 10.1% | 6.4% | 4.5% | NA |
| Years in practice | 18.0 | 18.0 | 15.0 | 14.3 |
| Geographic region | | | | |
| New England (CT,ME,MA,NH,RI,VT) | 4.5% | 5.7% | 5.7% | 7.1% |
| Middle Atlantic (NJ,NY,PA) | 11.8% | 15.3% | 14.4% | 14.6% |
| South Atlantic (DE,DC,FL,GA,MD,NC,SC,VA,WV) | 17.7% | 17.2% | 18.6% | 15.7% |
| East South Central (AL,KY,MS,TN) | 5.1% | 4.9% | 4.5% | 4.3% |
| East North Central (IL,IN,MI,OH,WI) | 17.3% | 14.4% | 14.7% | 15.0% |
| West North Central (IA,KS,MN,MO,NE,ND,SD) | 4.4% | 7.6% | 6.3% | 6.1% |
| Mountain (AZ,CO,ID,MT,NV,NM,UT,WY) | 7.7% | 7.1% | 6.6% | 7.6% |
| West South Central (AR,LA,OK,TX) | 11.5% | 10.6% | 10.5% | 10.1% |
| Pacific (AK,CA,HI,OR,WA) | 20.1% | 17.1% | 18.8% | 19.5% |
| Gross income* | | | | |
| \$200,000 or less | 5.5% | 5.3% | 8.3% | 7.0% |
| \$201,000-400,000 | 11.0% | 15.7% | 29.6% | 42.9% |
| \$401,000-600,000 | 16.8% | 27.0% | 33.2% | 33.6% |
| \$601,000-850,000 | 20.0% | 27.2% | 19.7% | 10.8% |
| \$851,000-1,100,000 | 18.6% | 13.7% | 6.4% | 2.6% |
| More than \$1,100,000 | 28.1% | 11.1% | 2.7% | NA |
| Affiliation with management service organization | 5.8% | NA | NA | NA |
| Active cases | 500 | 400 | 350 | 327 |
| Adult active cases | 20.0% | 20.0% | 25.0% | 20.4% |
| Two-phase treatment | 20.0% | 20.0% | 20.0% | NA |
| Youngest patient (years) | 6.0 | 6.0 | 6.0 | NA |
| Oldest patient (years) | 63.0 | 60.0 | 59.0 | NA |
| Age recommended to begin treatment (years) | 11.0 | 10.0 | 10.0 | NA |
| Normal appointment interval | | | | |
| 4 weeks | 18.2% | 51.2% | NA | NA |
| 5 weeks | 19.5% | 7.9% | NA | NA |
| 6 weeks | 43.3% | 34.1% | NA | NA |
| 8 weeks | 14.8% | 2.9% | NA | NA |
| 10 weeks | 1.8% | NA | NA | NA |
| 12 weeks | 0.3% | NA | NA | NA |
| Other | 2.2% | 3.9% | NA | NA |

*Annual income from preceding calendar year. Dollar amounts in each category have been adjusted upward to reflect national trends.

increase in female practitioners (Table 1). Gross income and numbers of active cases continued to increase, while the percentages of adult patients and two-phase patients remained constant at 20% each. About 6% of the respondents were affiliated with management service organizations.

Although the median age of the youngest patient stayed at 6, the median age of the oldest patient increased from 60 to 63, and the median age normally recommended to begin treatment rose from 10 to 11. The most common appointment interval increased from four weeks in 1996 to six weeks in 2002.

Diagnostic Records

Of the diagnostic records surveyed, most continued a gradual decline in routine usage since the 1986 Study, the only notable exceptions being panoramic x-rays and digital records (Table 2). About two-thirds of the respondents mounted casts in centric occlusion rather than in centric relation. The percentages that reported routinely mounting casts on articulators were about the same as in 1996, but fewer orthodontists routinely used bite registrations than in 1996. Nearly two-thirds of the clinicians used digital cameras routinely for pretreatment photographs in 2002, while more than half used them routinely for post-treatment photos. Digital photography was too new to be included on the questionnaire six years ago.

Slightly fewer respondents performed routine cephalometric analyses than in past studies, but the percentages who routinely used computerized tracings or analysis increased (Table 3). The relative popularity of particular analyses has stayed about the same since 1986, although none increased in routine usage between 1996 and 2002. The most commonly used analyses remained the Steiner, Ricketts, Tweed, Wits, Downs, and McNamara, in that order, while sizable numbers of respondents used "eyeball" or personalized analyses.

Routine use of archform analyses also continued to decline gradually, although slightly higher percentages used the Brader and Bonwill-

Hawley analyses routinely in 2002 than in 1996. Customized systems were used most often, followed by the Roth analysis, the clinician's own analysis, the Bolton Index, and the Tweed arch-length analysis.

Fixed Appliances

As in past studies, preadjusted fixed appliances were used routinely by a majority of respondents, although standard edgewise systems showed a substantial rise in usage (Table 4). The Roth prescription was by far the most common. Higher percentages of clinicians used Hyrax palatal expanders and transpalatal arches routinely in 2002 compared to 1996.

While almost all respondents continued to use stainless steel brackets, the mean number of patients with metal brackets dropped slightly between 1996 and 2002 (Table 5). More practices used ceramic, gold, and titanium brackets than in the last Study, but fewer used plastic and combination brackets. The .022" slot retained a slight edge over the .018" slot, and twin brackets were still much more popular than single brackets. Although miniaturized brackets were used in lower percentages of patients than in 1996, self-ligating and "reduced friction" brackets were used more often. The vast majority of brackets continued to have mesh bases, but microetched and chemically enhanced bases were more common than in 1996. Recycling of brackets dropped off considerably over the past six years.

More than 90% of orthodontists continued to use direct bonding routinely, but somewhat higher percentages used indirect bonding and glass ionomers than in 1996 (Table 6). More than 20% routinely used the new self-etching primers, as the percentage who routinely etched with 37% phosphoric acid declined. The median bond failure rate remained at 5%, with by far the most failures on the mandibular posterior teeth. Two-paste adhesives were still slightly more popular than one-paste adhesives among the chemically cured bonding agents. Light curing was used routinely by more than three-quarters of the respondents to the 2002 Study—a substan-

**TABLE 2
DIAGNOSTIC RECORDS USED ROUTINELY**

| | 2002 | | | 1996 | | | 1986 | | |
|----------------------------|----------|-----------|-----------|----------|-----------|-----------|----------|-----------|-----------|
| | Pre-tmt. | Pro-gress | Post-tmt. | Pre-tmt. | Pro-gress | Post-tmt. | Pre-tmt. | Pro-gress | Post-tmt. |
| X-rays | | | | | | | | | |
| Full series | 8.6% | 1.4 | 4.2 | 13.9% | 0.9% | 7.5% | 29.6% | 1.9% | 14.1% |
| Bite wings | 9.0 | 2.3 | 4.1 | 13.1 | 1.1 | 8.1 | 16.9 | 2.2 | 8.2 |
| Periapical | 14.2 | 6.5 | 7.9 | NA | NA | NA | NA | NA | NA |
| Panoramic | 97.2 | 57.9 | 79.1 | 94.9 | 51.3 | 81.4 | 86.3 | 38.3 | 69.0 |
| Cephalometric | | | | | | | | | |
| Lateral | 90.5 | 17.9 | 53.7 | 97.3 | 28.4 | 67.3 | 97.3 | 31.6 | 65.5 |
| Cephalostat | 55.2 | 12.3 | 29.8 | NA | NA | NA | NA | NA | NA |
| Natural head position | 22.5 | 4.3 | 11.4 | NA | NA | NA | NA | NA | NA |
| Frontal | 6.8 | 0.8 | 1.8 | 8.0 | 1.7 | 3.6 | 12.4 | 1.4 | 3.8 |
| Submental vertex | 2.3 | 0.3 | 1.4 | 1.6 | 0.5 | 0.8 | 3.8 | 0.1 | 0.7 |
| In centric occlusion | 40.5 | 7.4 | 15.6 | 50.8 | 28.6 | 39.1 | NA | NA | NA |
| In centric relation | 13.4 | 3.2 | 5.4 | 18.7 | 11.5 | 16.5 | NA | NA | NA |
| Laminagrams | 1.1 | 0.3 | 0.5 | 2.4 | 0.5 | 1.6 | 4.6 | 1.3 | 2.6 |
| Wrist x-ray | 3.5 | 0.5 | 0.3 | 4.4 | 0.9 | 1.0 | 9.2 | 0.7 | 1.1 |
| Computed tomography | 0.8 | 0.3 | 0.4 | 0.8 | 0.4 | 0.4 | 1.7 | 0.5 | 0.7 |
| Magnetic resonance imaging | 0.4 | 0.4 | 0.6 | 0.4 | 0.2 | 0.2 | NA | NA | NA |
| Digital radiography | 8.1 | 4.9 | 5.6 | NA | NA | NA | NA | NA | NA |
| Study casts | | | | | | | | | |
| In centric occlusion | 65.3 | 10.9 | 41.2 | 60.0 | 31.9 | 47.5 | NA | NA | NA |
| In centric relation | 30.8 | 7.6 | 17.0 | 34.9 | 20.5 | 27.9 | NA | NA | NA |
| Mounted on articulator | 13.3 | 3.3 | 5.4 | 12.5 | 6.8 | 8.1 | 13.3 | 3.9 | 6.5 |
| Bite registration | 68.4 | 13.6 | 29.2 | 82.6 | 54.1 | 67.0 | NA | NA | NA |
| Diagnostic setups | 2.7 | 0.8 | 0.9 | 1.7 | 0.7 | 1.0 | 10.4 | 1.3 | 1.3 |
| Virtual three-dimensional | 6.6 | 0.5 | 3.2 | NA | NA | NA | NA | NA | NA |
| Occlusograms | 1.6 | 0.4 | 0.6 | 1.3 | 0.4 | 0.9 | 3.4 | 0.7 | 9.9 |
| Height and weight charts | 4.2 | 0.6 | 0.5 | 6.4 | 2.5 | 3.1 | 9.6 | 1.7 | 2.2 |
| Growth charts | 3.5 | 1.0 | 0.6 | 4.1 | 1.6 | 1.9 | 4.8 | 0.7 | 0.8 |
| Mandibular kinesiograph | 0.1 | 0.1 | 0.0 | 0.5 | 0.3 | 0.3 | 1.0 | 0.4 | 0.4 |
| EMG | 0.0 | 0.0 | 0.0 | 0.5 | 0.3 | 0.3 | 1.1 | 0.5 | 0.5 |
| Transcranial TMJ x-rays | 1.1 | 0.4 | 0.5 | 2.2 | 0.8 | 1.1 | NA | NA | NA |
| Video imaging | 10.1 | 4.2 | 6.2 | 12.4 | 5.7 | 9.2 | NA | NA | NA |
| Photographs | | | | | | | | | |
| 35mm intraoral | 28.9 | 4.3 | 23.2 | 82.2 | 24.9 | 71.2 | NA | NA | NA |
| 35mm extraoral | 29.0 | 3.7 | 22.3 | 81.1 | 23.4 | 69.4 | NA | NA | NA |
| Polaroid intraoral | 2.4 | 0.5 | 1.9 | 8.8 | 1.8 | 6.4 | NA | NA | NA |
| Polaroid extraoral | 7.2 | 0.9 | 4.4 | 20.7 | 3.4 | 16.9 | NA | NA | NA |
| Digital intraoral | 65.7 | 18.3 | 53.0 | NA | NA | NA | NA | NA | NA |
| Digital extraoral | 65.5 | 18.3 | 53.4 | NA | NA | NA | NA | NA | NA |

TABLE 3
CEPHALOMETRIC AND ARCHFORM ANALYSES USED ROUTINELY

| | 2002 | 1996 | 1990 | 1986 |
|-------------------------------|-------|-------|-------|-------|
| Cephalometric | | | | |
| Pretreatment | 82.2% | 89.9% | 89.9% | 89.8% |
| Progress | 15.2 | 20.2 | 16.8 | 17.2 |
| Post-treatment | 33.2 | 44.4 | 46.9 | 44.7 |
| Alabama | 0.4 | 1.1 | 0.7 | NA |
| Burstone | 1.8 | 3.1 | 2.0 | NA |
| Downs | 16.4 | 22.4 | 25.4 | 26.3 |
| Holdaway | 8.8 | 13.3 | 13.9 | NA |
| Jarabak | 7.9 | 7.8 | 7.6 | NA |
| McNamara | 12.7 | 14.2 | 16.5 | 15.5 |
| Northwestern | 2.3 | 2.4 | 3.6 | 4.4 |
| Ricketts | 23.6 | 27.6 | 27.4 | 23.8 |
| Sassouni | 3.6 | 5.3 | 4.3 | 3.9 |
| Steiner | 35.1 | 39.7 | 43.3 | 38.3 |
| Tweed | 19.2 | 27.9 | 27.1 | 27.3 |
| Vari-Simplex | 1.4 | 2.9 | 3.4 | NA |
| Viazis | 0.3 | NA | NA | NA |
| Wits | 17.4 | 22.3 | 22.1 | NA |
| "Eyeball" | 18.1 | 16.7 | 16.3 | NA |
| Own analysis | 19.9 | 26.3 | 21.1 | NA |
| Other | 7.1 | 7.5 | 7.6 | 13.5 |
| Manual tracing | 48.0 | 61.2 | 76.6 | 81.0 |
| Computerized tracing | 28.6 | 20.3 | 11.4 | 8.3 |
| Computer imaging and analysis | 18.3 | 12.4 | 3.4 | NA |
| Templates | 2.4 | 4.8 | NA | NA |
| VTO | 6.3 | 7.5 | 8.5 | 7.0 |
| Archform | | | | |
| Tweed arch length | 5.5 | 7.3 | 9.5 | 10.7 |
| Bolton Index | 8.6 | 10.8 | 10.5 | 11.6 |
| Pont's Index | 0.1 | 0.6 | 1.0 | 1.8 |
| Bonwill-Hawley | 1.8 | 1.7 | 4.7 | 9.2 |
| Andrews | 2.7 | NA | NA | NA |
| Brader | 5.0 | 3.9 | 9.2 | NA |
| Ricketts | 4.2 | NA | NA | NA |
| Roth | 15.8 | 19.5 | 23.0 | NA |
| Vari-Simplex | 3.2 | 4.8 | 3.4 | NA |
| Customized | 17.1 | 25.8 | 26.5 | 45.1 |
| Own analysis | 12.6 | 22.3 | 18.8 | NA |
| Other | 5.4 | 2.4 | 3.7 | 9.8 |

tial jump over the 1996 results. One-paste adhesives held a decided edge over precoated brackets and two-paste adhesives. The median curing time was 20 seconds per tooth, and intense visible light was used routinely by slightly more respondents than standard visible light.

Compared to the 1996 Study, more respondents used light-cured glass ionomer band cements routinely, but fewer used standard glass ionomer band cements (Table 7). Compomers and zinc phosphates were used routinely by only a few clinicians.

The only teeth that were routinely banded by a majority of orthodontists in 2002 were sec-

ond molars, but all molars and premolars were banded less routinely than in the past (Table 8). Mandibular second molars were somewhat more likely to be bonded than other molars, but were still bonded routinely by less than one-third of the respondents.

The current Study showed a marked increase in usage of titanium alloys for initial archwires, with stainless steel still used by most practitioners for finishing archwires (Table 9). The median number of archwires used in each arch was four in both extraction and nonextraction cases.

**TABLE 4
FIXED APPLIANCES USED ROUTINELY**

| | 2002 | 1996 | 1990 | 1986 |
|------------------------------|------|------|------|------|
| Begg | 0.4% | 0.9% | 2.3% | 5.2% |
| Bidimensional | 4.0 | NA | NA | NA |
| Bioprogressive | 6.0 | 8.6 | 7.9 | 10.9 |
| Lingual | 0.6 | 1.3 | 1.3 | 1.1 |
| MEAW | 0.1 | NA | NA | NA |
| Preadjusted prescription | NA | 76.4 | 64.7 | 66.8 |
| Andrews | 7.3 | NA | NA | NA |
| Hilgers | 2.0 | NA | NA | NA |
| MBT | 6.6 | NA | NA | NA |
| Orthos | 8.7 | NA | NA | NA |
| Roth | 55.9 | NA | NA | NA |
| Vari-Simplex | 5.1 | NA | NA | NA |
| Other | 8.8 | NA | NA | NA |
| Self-ligating | 8.7 | NA | NA | NA |
| Standard edgewise | 48.0 | 22.9 | 20.0 | 24.2 |
| Tip-Edge | 2.0 | 2.4 | 3.3 | 2.5 |
| Other | 1.2 | 4.5 | 4.3 | 2.5 |
| Magnetic appliances | 0.0 | 0.2 | NA | NA |
| Palatal expansion appliances | | | | |
| Haas | 17.6 | 20.9 | NA | NA |
| Hyrax | 56.1 | 49.0 | NA | NA |
| Quad Helix | 18.3 | 21.7 | NA | NA |
| Other | 5.9 | 7.6 | NA | NA |
| Transpalatal arches | 29.1 | 26.2 | NA | NA |

Other Appliances

The only removable and functional appliances used routinely by more orthodontists in 2002 than in past studies were the banded and crowned Herbst appliances and the Hilgers Pendulum (Table 10). Invisalign appliances were routinely prescribed by 11% of the respondents in the first appearance of this method on the questionnaire.

A trend toward outside laboratory rather

than in-office fabrication of functional appliances continued (Table 11). The only appliances constructed in-house by a majority of respondents were bite plates, the Class II Corrector, the Forsus, the Jasper Jumper, and the Jones Jig (the latter three being prefabricated).

Routine use of headgear decreased markedly between 1996 and 2002 (Table 12). Only chin cups and facial masks were used routinely by higher percentages of clinicians than ever before, and those by fewer than 13% each.

**TABLE 5
BRACKETS**

| | 2002 | | 1996 | | 1990 | | 1986 | |
|-------------------------------|-------|-------|-------|-------|-------|-------|-------|--------|
| | Use | Mean | Use | Mean | Use | Mean* | Use | Mean* |
| Stainless steel | 98.1% | 85.0% | 99.6% | 89.7% | 98.5% | | 93.6% | |
| Ceramic | 79.9 | 10.2 | 65.4 | 6.1 | 88.2 | | 5.6 | |
| Plastic | 9.5 | 0.9 | 22.5 | 1.8 | 24.3 | | 57.8 | |
| Gold | 31.8 | 2.2 | 15.4 | 0.6 | NA | | NA | |
| Titanium | 5.0 | 0.8 | 2.0 | 0.2 | NA | | NA | |
| Combination | 12.7 | 2.2 | 25.5 | 3.4 | NA | | 26.6 | |
| .018" slot | | 40.5 | | 47.1 | | 46.0 | | 49.3 |
| .022" slot | | 54.2 | | 53.2 | | 53.1 | | 50.7 |
| Bidimensional slot | | 4.3 | | NA | | NA | | NA |
| Other slot | | 4.3 | | 0.7 | | 0.5 | | NA |
| Single | | 11.6 | | 17.6 | | NA | | NA |
| Twin | | 88.4 | | 82.0 | | NA | | NA |
| Standard size | | 38.5 | | 39.4 | | NA | | NA |
| Miniaturized | | 46.8 | | 61.8 | | NA | | NA |
| Self-ligating | | 9.8 | | 1.6 | | NA | | NA |
| "Reduced friction" | | 3.7 | | 2.1 | | NA | | NA |
| Mesh base | | 90.9 | | 90.8 | | NA | | NA |
| Non-mesh base | | 2.6 | | 3.8 | | NA | | NA |
| Chemically enhanced base | | 4.0 | | 2.9 | | NA | | NA |
| Microetched base (laboratory) | | 13.0 | | 7.2 | | NA | | NA |
| Sandblasted base (in-office) | | 5.2 | | 5.7 | | NA | | NA |
| Recycling | 8.5 | | 24.8 | | 31.6 | | 35.0 | |
| Metal | | 4.0 | | 12.9 | | 57.0 | | 49.9** |
| Ceramic | | 0.2 | | 1.8 | | 8.5 | | NA |

*Not reported by bracket material in 1990 and 1986.

**1986 figure is median percentage of all brackets.

TABLE 6
BONDING PROCEDURES USED ROUTINELY

| | 2002 | 1996 | 1990 | 1986* |
|---|-------|-------|-------|-------|
| Direct bonding | 91.1% | 92.8% | 91.8% | 96.8% |
| Indirect bonding | 9.6% | 7.7% | 7.8% | 22.8% |
| Light curing | 75.6% | 46.2% | 20.2% | NA |
| Glass ionomer | 18.1% | 14.4% | 5.2% | NA |
| Sealant | 41.8% | 54.7% | 60.0% | 74.8% |
| Self-etching primer | 22.4% | NA | NA | NA |
| Phosphoric acid etchant | 77.0% | 91.5% | 80.2% | NA |
| Concentration (median) | 37.0% | 37.0% | 37.0% | 37.1% |
| Time in seconds (median) | 30.0 | 30.0 | 50.0 | 60.0 |
| Bond failure rate (median) | 5.0% | 5.0% | 5.0% | 5.3% |
| Highest bond failure rate | | | | |
| Maxillary anterior teeth | 3.1% | NA | NA | NA |
| Maxillary posterior teeth | 12.8% | NA | NA | NA |
| Mandibular anterior teeth | 7.3% | NA | NA | NA |
| Mandibular posterior teeth | 76.7% | NA | NA | NA |
| Type of adhesive (chemically cured) | | | | |
| One-paste | 21.6% | 40.5% | NA | NA |
| Two-paste | 23.0% | 44.1% | NA | NA |
| Other | 1.5% | 3.5% | NA | NA |
| Type of adhesive (light-cured) | | | | |
| One-paste | 67.2% | NA | NA | NA |
| Two-paste | 8.7% | NA | NA | NA |
| Precoated | 12.1% | NA | NA | NA |
| Other | 1.0% | NA | NA | NA |
| Light exposure per tooth in seconds (median) | 20.0 | NA | NA | NA |
| Preferred curing light | | | | |
| Standard visible | 45.7% | NA | NA | NA |
| Intense visible | 50.7% | NA | NA | NA |
| Laser | 2.8% | NA | NA | NA |
| Other | 0.7% | NA | NA | NA |

*1986 responses were not broken down by frequency of use.

TABLE 7
USE OF BAND CEMENTS

| | 2002 | | | 1996 | | |
|-------------------------------------|-------|-------------------|-----------|-------|-------------------|-----------|
| | Never | Occa- sionally | Routinely | Never | Occa- sionally | Routinely |
| Glass ionomer | 48.8% | 8.2% | 43.0% | 22.0% | 20.0% | 58.0% |
| Light-cured glass ionomer | 55.9 | 8.7 | 35.4 | 47.9 | 24.9 | 27.2 |
| One-paste compomer (light-cured) | 84.4 | 2.9 | 12.6 | NA | NA | NA |
| Two-paste compomer | 92.8 | 1.9 | 5.2 | NA | NA | NA |
| Zinc phosphate | 90.0 | 2.6 | 7.4 | 63.5 | 14.6 | 21.9 |
| Other | 98.2 | 0.9 | 0.9 | 97.8 | 0.3 | 1.9 |

**TABLE 8
ROUTINE BANDING OR BONDING**

| | 2002 | 1996 | 1986 |
|-----------------------------|-------|-------|-------|
| Banding | | | |
| Maxillary second molars | 24.1% | 27.7% | 25.2% |
| Maxillary first molars | 76.2 | 90.8 | 92.2 |
| Maxillary second premolars | 13.9 | 23.8 | 40.7 |
| Maxillary first premolars | 6.4 | 9.4 | 21.0 |
| Mandibular second molars | 36.7 | 51.4 | 51.4 |
| Mandibular first molars | 72.8 | 89.5 | 91.0 |
| Mandibular second premolars | 16.0 | 26.2 | 42.5 |
| Mandibular first premolars | 6.3 | 8.9 | 22.0 |
| Bonding | | | |
| Maxillary second molars | 21.7 | NA | NA |
| Maxillary first molars | 21.8 | NA | NA |
| Mandibular second molars | 30.4 | NA | NA |
| Mandibular first molars | 21.7 | NA | NA |

**TABLE 9
ARCHWIRES USED ROUTINELY**

| | 2002 | | 1996 | 1990* |
|---|-------|-----------|-------|--------|
| | Early | Finishing | | |
| Stainless steel | 49.0% | 79.2% | 88.4% | 89.7% |
| Multi stranded/braided stainless steel | 17.2 | 5.6 | 33.8 | 72.1 |
| Nickel titanium | 80.2 | 11.0 | 75.8 | 90.4** |
| Multi stranded/braided nickel titanium | 2.4 | 0.8 | NA | NA |
| Chrome cobalt nickel | 8.3 | 3.0 | NA | NA |
| Titanium molybdenum | 13.5 | 16.6 | 22.5 | NA |
| Titanium niobium | 0.9 | 0.4 | NA | NA |
| Thermally activated titanium | 26.8 | 2.4 | 24.9 | NA |
| Coated | 1.3 | 0.1 | 1.1 | NA |
| Other | 2.1 | 0.3 | 2.4 | NA |
| Number of archwires in typical sequence (median) | | | | |
| Extraction | | | 5 | NA |
| Maxillary | 4 | | | |
| Mandibular | 4 | | | |
| Nonextraction | | | 4 | NA |
| Maxillary | 4 | | | |
| Mandibular | 4 | | | |

*1990 responses were not broken down by frequency of use.

**Includes all alloys other than stainless steel.

Extractions

Although almost all respondents continued to treat at least some cases with extractions, the median percentage of extraction cases reached an all-time low of 20% (Table 13). The most common extraction prescription remained four first premolars, followed by other combinations of first and second premolars.

Third molars represented a mean of only about 11% of all extractions, while about 19% of the respondents used third molar enucleation. Most orthodontists continued to prescribe serial extractions when needed, and more than one-

third used sectional wires for initial cuspid retraction in extraction cases.

Finishing and Retention

The cosmetic finishing procedures surveyed continued to reflect an upward trend in routine use (Table 14). More than two-thirds of the respondents in 2002 routinely performed incisal adjustments and some method of anterior stripping. More than one-third routinely performed posterior stripping, and about one-fourth routinely used zig-zag elastics.

**TABLE 10
REMOVABLE AND FUNCTIONAL APPLIANCES USED ROUTINELY**

| | 2002 | 1996 | 1990 | 1986 |
|-----------------------|------|------|------|------|
| Activator | 0.8% | 1.7% | 2.8% | 4.0% |
| Bass | 0.0 | 0.0 | 0.1 | NA |
| Bionator | 4.9 | 6.1 | 12.8 | 13.1 |
| Bite plates | 18.1 | 27.9 | 23.1 | 14.3 |
| Class II Corrector | 3.6 | NA | NA | NA |
| Distal Jet | 2.1 | NA | NA | NA |
| Forsus | 2.2 | NA | NA | NA |
| Fränkel | 1.5 | 3.0 | 5.1 | 5.9 |
| Herbst | | | | |
| Banded | 7.6 | 4.5 | 4.0 | 0.9 |
| Bonded | 1.5 | 2.3 | 2.1 | 1.6 |
| Crowns | 22.6 | 11.0 | NA | NA |
| Removable | 1.3 | 3.0 | 3.3 | 1.3 |
| Fixed-removable | 1.9 | NA | NA | NA |
| Hilgers Pendulum | 12.9 | 10.0 | NA | NA |
| Invisalign | 11.0 | NA | NA | NA |
| Jasper Jumper | 4.7 | 5.3 | 4.2 | NA |
| Jones Jig | 0.4 | NA | NA | NA |
| Magnets | 0.0 | 0.2 | NA | NA |
| Mandibular Corrector | 0.1 | 1.4 | 1.7 | 2.8 |
| Mandibular Protrusion | 0.3 | 0.7 | NA | NA |
| MARA | 3.1 | NA | NA | NA |
| Sagittal | 4.0 | 8.1 | 8.3 | 7.5 |
| Schwarz plates | 8.9 | 13.0 | 10.6 | 5.9 |
| Twin block | 4.4 | NA | NA | NA |
| Other | 4.6 | 4.7 | 3.9 | 1.2 |

**TABLE 11
FABRICATION OF REMOVABLE AND FUNCTIONAL APPLIANCES**

| | 2002 | | 1996 | | 1990 | | 1986 | |
|-----------------------|-----------|-------------|-----------|-------------|-----------|-------------|-----------|-------------|
| | In-Office | Outside Lab | In-Office | Outside Lab | In-Office | Outside Lab | In-Office | Outside Lab |
| Activator | 18.6% | 81.4% | 14.3% | 85.7% | 20.1% | 79.9% | NA | NA |
| Bass | 25.0 | 75.0 | 12.7 | 87.3 | 26.8 | 73.2 | NA | NA |
| Bionator | 10.7 | 89.3 | 10.9 | 89.1 | 12.7 | 87.3 | 11.1 | 88.9 |
| Bite plates | 50.1 | 49.9 | 52.7 | 47.3 | 58.3 | 41.7 | 65.7 | 34.3 |
| Class II Corrector | 51.8 | 48.2 | NA | NA | NA | NA | NA | NA |
| Distal Jet | 19.0 | 81.0 | NA | NA | NA | NA | NA | NA |
| Forsus | 79.2 | 20.8 | NA | NA | NA | NA | NA | NA |
| Fränkel | 13.6 | 86.4 | 9.2 | 90.8 | 8.4 | 91.6 | 5.5 | 94.5 |
| Herbst | | | | | | | | |
| Banded | 15.3 | 84.7 | 17.1 | 82.9 | 29.4 | 70.6 | 25.2 | 74.8 |
| Bonded | 20.0 | 80.0 | 15.7 | 84.3 | 17.8 | 82.2 | 13.0 | 87.0 |
| Crowns | 21.7 | 78.3 | 15.1 | 84.9 | NA | NA | NA | NA |
| Removable | 10.7 | 89.3 | 15.8 | 84.2 | 18.5 | 81.5 | 21.6 | 78.4 |
| Fixed-removable | 22.5 | 77.5 | NA | NA | NA | NA | NA | NA |
| Hilgers Pendulum | 27.3 | 72.7 | 30.1 | 69.9 | NA | NA | NA | NA |
| Invisalign | 4.8 | 95.2 | NA | NA | NA | NA | NA | NA |
| Jasper Jumper | 76.2 | 23.8 | 51.5 | 48.5 | 65.5 | 34.5 | NA | NA |
| Jones Jig | 67.4 | 32.6 | NA | NA | NA | NA | NA | NA |
| Magnets | 18.2 | 81.8 | 21.8 | 78.2 | NA | NA | NA | NA |
| Mandibular Corrector | 42.9 | 57.1 | 15.6 | 84.4 | 24.2 | 75.8 | 24.6 | 75.4 |
| Mandibular Protrusion | 9.1 | 90.9 | 16.8 | 83.2 | NA | NA | NA | NA |
| MARA | 11.4 | 88.6 | NA | NA | NA | NA | NA | NA |
| Sagittal | 22.7 | 77.3 | 24.9 | 75.1 | 28.6 | 71.4 | 21.1 | 78.9 |
| Schwarz plates | 26.2 | 73.8 | 26.3 | 73.7 | 32.5 | 67.5 | 29.7 | 70.3 |
| Twin block | 17.9 | 82.1 | NA | NA | NA | NA | NA | NA |

**TABLE 12
HEADGEAR USED ROUTINELY**

| | 2002 | 1996 | 1990 | 1986 |
|------------------------|-------|-------|-------|-------|
| Kloehn facebow | 23.9% | 35.6% | 36.5% | 41.0% |
| J-hook | 3.0 | 5.6 | 5.2 | 8.1 |
| Cervical-pull | 32.5 | 42.2 | 41.5 | 35.6 |
| Straight-pull | 5.3 | 10.6 | 7.8 | 8.1 |
| Variable straight-pull | 2.4 | 4.7 | 4.2 | 4.0 |
| High-pull | 20.9 | 27.8 | 26.6 | 20.7 |
| Combi | 5.5 | 9.3 | 9.4 | 6.8 |
| Reverse | 11.2 | 12.5 | 5.1 | 2.1 |
| Chin cup | 2.6 | 1.4 | 2.2 | 2.0 |
| Facial mask | 12.9 | 12.1 | 5.3 | 1.7 |
| Other | 0.7 | 0.7 | 0.5 | NA |
| Safety or breakaway | 45.5 | 68.1 | 54.3 | 45.9 |

**TABLE 13
EXTRACTIONS**

| | 2002 | 1996 | 1990 | 1986 |
|--|-------------|-------------|-------------|-------------|
| Treated at least one extraction case | 95.3% | 92.1% | 87.7% | 95.0% |
| Percentage of active cases (median) | 20.0 | 22.0 | 25.0 | 34.9 |
| Percentage of extraction cases* | | | | |
| Maxillary first premolars | 22.2 | 23.1 | 20.2 | NA |
| Mandibular first premolars | 8.0 | 9.9 | 9.0 | NA |
| Maxillary, mandibular first premolars | 43.0 | 48.5 | 42.9 | 74.7 |
| Maxillary, mandibular second premolars | 6.0 | 7.0 | 5.8 | 5.4 |
| Maxillary first, mandibular second premolars | 7.5 | 8.4 | 8.5 | 9.8 |
| Maxillary second, mandibular first premolars | 1.7 | 2.1 | 0.9 | 2.2 |
| Maxillary, mandibular first molars | 0.2 | 0.4 | 0.4 | NA |
| Maxillary second molars | 0.6 | 1.1 | 1.4 | 1.9 |
| Mandibular second molars | 0.1 | 0.3 | 0.3 | 0.5 |
| Maxillary, mandibular second molars | 0.2 | 0.6 | 0.7 | NA |
| Maxillary, mandibular third molars | 10.9 | 23.0 | 16.9 | NA |
| Mandibular incisors | 2.5 | NA | NA | NA |
| Other | 0.5 | 0.8 | 1.2 | 9.6 |
| Use third molar enucleation | 18.9 | 23.4 | 18.9 | 19.2 |
| Use serial extraction | 73.4 | 78.2 | 67.9 | 62.1 |
| Use sectional wires for initial cuspid retraction | 34.3 | 31.9 | NA | NA |

*2002, 1996, and 1990 figures are means; 1986 figures are medians.

**TABLE 14
FINISHING PROCEDURES USED ROUTINELY**

| | 2002 | 1996 | 1990 | 1986 |
|-----------------------------------|-------------|-------------|-------------|-------------|
| Cosmetics | | | | |
| Incisal adjustment | 67.9% | 54.9% | 52.8% | 46.2% |
| Shaping labial/lingual surface* | 28.7 | 13.6 | 12.2 | 9.8 |
| Porcelain laminate veneers | 3.3 | NA | NA | NA |
| Composite resin build-up | 6.0 | 3.6 | 2.5 | 3.2 |
| Anterior stripping (slenderizing) | | | | |
| With hand instruments | 33.9 | 25.8 | 23.7 | 26.1 |
| With handpiece | 30.1 | 21.4 | 19.2 | 13.1 |
| With air turbine | 13.1 | 9.5 | 8.8 | 9.8 |
| Posterior stripping | | | | |
| With hand instruments | 11.1 | 6.4 | NA | NA |
| With handpiece | 17.7 | 14.0 | NA | NA |
| With air turbine | 12.4 | 3.1 | NA | NA |
| Fiberotomy | 7.3 | | | |
| By orthodontist | NA | 1.8 | 2.3 | 3.0 |
| By periodontist | NA | 11.2 | 9.3 | 8.9 |
| By GP | NA | 3.0 | 3.6 | 4.0 |
| By oral surgeon | NA | 4.5 | NA | NA |
| Gingivectomy | 2.3 | NA | NA | NA |
| Frenulotomy | 8.6 | NA | NA | NA |
| Zig-zag (up-and-down) elastics | 26.1 | 25.5 | NA | NA |
| Equilibration | 14.2 | 10.8 | 15.5 | 17.2 |
| Positioner | 5.2 | 3.8 | 10.2 | 15.5 |

*1996, 1990, and 1986 figures refer to labial surface only; lingual surface was reported separately.

TABLE 15
RETENTION METHODS USED ROUTINELY

| | 2002 | 1996 | 1990 | 1986 |
|----------------------------|-------|-------|-------|-------|
| Removable | | | | |
| Hawley | 63.6% | 77.4% | 79.9% | 86.7% |
| Spring retainer | 14.6 | 20.4 | 19.9 | 15.7 |
| Modified spring retainer | 8.4 | 16.1 | 13.7 | 8.1 |
| Clear slipover (invisible) | 29.5 | 25.8 | 16.9 | 5.7 |
| Essix | 22.5 | 12.5 | NA | NA |
| Invisalign | 3.9 | NA | NA | NA |
| Other | 3.0 | 3.5 | 4.4 | 4.0 |
| Fixed banded | | | | |
| 3-3 | 6.3 | 4.6 | 6.0 | 13.5 |
| 4-4 | 1.0 | 1.9 | 2.6 | 6.1 |
| 5-5 | 0.7 | 0.9 | 0.7 | 2.0 |
| 6-6 | 0.1 | 1.8 | 1.6 | 1.0 |
| Fixed bonded | | | | |
| Maxillary | 5.2 | NA | NA | NA |
| Mandibular | 32.0 | NA | NA | NA |
| 2-2 | 3.0 | NA | NA | NA |
| 3-3 | 39.4 | 36.8 | 32.0 | 27.7 |
| 4-4 | 1.1 | 1.2 | 1.8 | 1.4 |
| Specific retention period | 43.7% | 48.8% | 47.0% | NA |
| Number of months (median) | 24.0 | 24.0 | 24.0 | 24.0 |
| Long-term (up to 10 years) | 29.2% | 28.3% | 38.3% | NA |
| Permanent | 27.2% | 23.2% | 14.7% | NA |
| Number of visits (median) | 5.0 | NA | NA | NA |

Although the Hawley retainer remained the most commonly used, “invisible” types of retainers continued to gain in popularity (Table 15). Fixed banded retainers continued to decline in routine usage, but fixed bonded retainers continued to increase, with nearly one-third of the clinicians using them routinely in the mandibular arch. Compared to the past two surveys, slightly fewer respondents specified a retention period (with a median of 24 months), and more respondents said they prescribed “permanent” retention.

TMJ and Surgical-Orthodontic Treatment

As in the 1996 Study, more than 70% of the respondents reported treating at least one TMJ case in the preceding year, with a median of five

patients and a median of 50% combined with orthodontic treatment (Table 16). With successful treatment defined as “asymptomatic one year post-treatment”, the median success rate dropped from 80% to its 1990 level of 75%. Although the only diagnostic materials used more in 2002 than ever before were tomograms, nearly all the respondents still used health histories and muscle palpation, and a majority used mounted casts.

Most of the clinicians attributed TMJ dysfunction to a combination of causes, but the most significant was considered to be stress, followed by trauma and muscle dysfunction (Table 17). Occlusion, mutilated dentition, pathology, and anatomy were all rated somewhat significant.

Splints remained the most routinely used TMJ treatment method, followed by non-steroidal anti-inflammatory drugs and palliative

**TABLE 16
TMJ DIAGNOSIS AND TREATMENT**

| | 2002 | 1996 | 1990 | 1986 |
|--|-------|-------|-------|-------|
| Treated at least one case | 71.4% | 73.1% | 74.5% | 70.0% |
| Median number of cases treated in preceding year | 5.0 | 5.0 | 15.0 | 12.5 |
| Patient distribution (medians) | | | | |
| Combined with orthodontics | 50.0% | 50.0% | 67.5% | 75.4% |
| Referred to oral surgeon | 1.0 | 5.0 | 2.0 | 3.7 |
| Referred to physician | 0.0 | NA | NA | NA |
| Referred to general dentist | 0.0 | NA | NA | NA |
| Referred for psychological evaluation | 0.0 | 0.0 | 0.0 | 0.4 |
| Success rate (one year post-treatment) | 75.0 | 80.0 | 75.0 | 75.3 |
| Diagnostic materials used | | | | |
| History | 92.5% | 99.7% | 99.8% | 92.2% |
| Muscle palpation | 90.6 | 95.0 | 95.4 | 85.5 |
| Local anesthetic | 4.0 | 2.6 | 4.3 | NA |
| EMG | 0.8 | 2.1 | 3.4 | 3.3 |
| TENS | 1.9 | 5.5 | 6.8 | 6.2 |
| Mandibular kinesiograph | 1.1 | 1.4 | 2.6 | 1.8 |
| MRI images | 15.2 | 23.8 | 25.3 | NA |
| Transcranial x-rays | 17.1 | 24.3 | 30.2 | NA |
| Arthrograms | 5.3 | 13.2 | 18.0 | NA |
| Therapeutic diagnosis | 36.1 | 39.5 | 39.3 | 29.1 |
| Tomograms | 30.7 | 24.2 | 29.4 | 27.9 |
| Mounted casts | 52.8 | 59.9 | 67.0 | 48.2 |

**TABLE 17
OPINION OF CAUSES OF TMD**

| | Highly Significant (3) | Somewhat Significant (2) | Not Significant (1) | Mean |
|---------------------|------------------------|--------------------------|---------------------|------|
| Stress | 82.6% | 12.3% | 5.1% | 2.8 |
| Trauma | 58.7 | 35.5 | 5.9 | 2.5 |
| Muscle dysfunction | 52.9 | 37.8 | 9.3 | 2.4 |
| Occlusion | 22.3 | 65.2 | 12.5 | 2.1 |
| Mutilated dentition | 18.3 | 59.6 | 22.0 | 2.0 |
| Pathology | 23.3 | 47.0 | 29.7 | 1.9 |
| Anatomy | 17.2 | 52.0 | 30.7 | 1.9 |

therapy such as reassurance, heat, and cold (Table 18). Other methods used more routinely in 2002 than ever before, though still by small numbers of respondents, were myofunctional therapy, acupuncture, osteopathic manipulation, and orthognathic surgery.

Nearly all orthodontists reported treating at least one surgical-orthodontic case in 2001, but

the median number of cases remained at five (Table 19). A few more respondents said the majority of treatment-planning decisions were made by the orthodontist as opposed to a team. As in previous surveys, a median of 50% of the surgeries were mandibular and 25% involved both jaws; only 6% were maxillary, fewer than before. (These groups of figures do not add up to

TABLE 18
TMJ TREATMENT METHODS USED ROUTINELY

| | 2002 | 1996 | 1990 | 1986 |
|---------------------------------|-------|-------|-------|-------|
| Upper splint | 60.0% | 53.6% | 55.6% | 54.1% |
| Lower splint | 27.4 | 24.6 | 27.9 | 25.8 |
| Functional appliances | 5.5 | 3.2 | 4.7 | 7.8 |
| Fixed appliances | 18.1 | 15.6 | 22.9 | NA |
| Equilibration | 12.4 | 7.9 | 12.7 | 18.3 |
| TENS | 0.7 | 1.8 | 1.6 | 2.9 |
| EGS | 0.4 | 0.7 | 0.9 | 1.2 |
| Ultrasonic heat | 1.3 | 2.2 | 3.2 | NA |
| Fluoromethane spray and stretch | 1.8 | 2.1 | 2.6 | NA |
| Hypnosis | 0.0 | 0.0 | 0.0 | 0.1 |
| Biofeedback | 1.3 | 1.2 | 1.8 | 1.2 |
| Myofunctional therapy | 3.5 | 1.2 | 2.9 | 3.0 |
| Acupuncture | 1.5 | 0.6 | 1.1 | 0.2 |
| Palliative | 30.7 | 28.0 | 28.6 | 22.4 |
| Drug therapy | NA | NA | NA | 3.4 |
| Anti-inflammatory | NA | 25.7 | 21.4 | NA |
| Non-steroidal | 39.5 | NA | NA | NA |
| Corticosteroids | 1.1 | NA | NA | NA |
| Muscle relaxant | 6.4 | 8.1 | 7.7 | NA |
| Narcotic | 0.7 | NA | NA | NA |
| Anti-anxiety | 1.1 | NA | NA | NA |
| Antidepressant | 1.5 | NA | NA | NA |
| Anticonvulsant | 0.0 | NA | NA | NA |
| Iontophoresis | 0.4 | 0.7 | 0.3 | NA |
| Applied kinesiology | 0.4 | 0.4 | 0.9 | 0.9 |
| Osteopathic manipulation | 0.9 | 0.6 | 0.3 | 0.6 |
| Physical therapy | 11.7 | 14.0 | 15.3 | NA |
| Arthroscopy | 0.2 | 1.1 | 0.6 | NA |
| Orthognathic surgery | 2.4 | 0.6 | 0.7 | NA |
| Other | 2.2 | 1.1 | 2.1 | 3.8 |

100% because medians are reported instead of means.) The median percentage of Class II patients remained at 50%, while the percentage of Class III patients rose slightly to 30%. As in the past, the orthodontist was entirely satisfied with a median 80% of the results, and the patient was entirely satisfied a median 90% of the time.

(TO BE CONTINUED)

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**TABLE 19
SURGICAL-ORTHODONTIC TREATMENT**

| | 2002 | 1996 | 1990 | 1986 |
|---|-------------|-------------|-------------|-------------|
| Treated at least one case | 95.3% | 89.8% | 81.0% | 81.0% |
| Median number of cases treated in preceding year | 5.0 | 5.0 | 8.0 | 6.6 |
| Majority of treatment-planning decisions made by: | | | | |
| Orthodontist | 45.3% | 41.6% | 43.2% | 81.1% |
| Oral surgeon | 10.8 | 8.0 | 7.9 | 16.3 |
| Team | 43.7 | 50.4 | 48.9 | NA |
| Other | 0.2 | 0.0 | 0.1 | 2.7 |
| Orthodontics provided first in: | | | | |
| All cases | 90.5% | 88.7% | 83.4% | 79.6% |
| Most cases | 8.7 | 9.8 | 14.9 | 18.6 |
| Some cases | 0.8 | 1.5 | 1.4 | 1.5 |
| No cases | 0.0 | 0.0 | 0.3 | 0.3 |
| Patient distribution (medians) | | | | |
| Mandible only | 50.0% | 45.0% | 50.0% | 50.0% |
| Maxilla only | 6.0 | 10.0 | 15.0 | 25.0 |
| Both jaws | 25.0 | 25.0 | 20.0 | 25.0 |
| Class II cases | 50.0 | 50.0 | NA | NA |
| Class III cases | 30.0 | 25.0 | NA | NA |
| Others | 0.0 | 0.0 | NA | NA |
| Orthodontist entirely satisfied with result | 80.0 | 75.0 | 75.0 | 80.0 |
| Fairly satisfied | 10.0 | 10.0 | 10.0 | 20.2 |
| Not satisfied | 0.0 | 0.0 | 0.0 | 9.6 |
| Patient entirely satisfied with result | 90.0 | 90.0 | 90.0 | 90.2 |
| Fairly satisfied | 0.0 | 5.0 | 5.0 | 10.3 |
| Not satisfied | 0.0 | 0.0 | 0.0 | 1.8 |