Coll. Antropol. **30** (2006) 1: 31–35
Original scientific paper

Measurement of Tooth Extraction Forces in Upper Incisors

Vladimir Ahel[1], Ivana Brekalo[2], Juraj Ahel[3] and Gordana Brumini[4]

[1] Department of Oral and Maxillofacial Surgery, University Hospital Rijeka, Rijeka, Croatia
[2] Department of Dental Pathology, School of Medicine, University of Rijeka, Rijeka, Croatia
[3] Department of Surgery, University Hospital Rijeka, Rijeka, Croatia
[4] Department of Informatics, School of Medicine, University of Rijeka, Rijeka, Croatia

A B S T R A C T

A new method, applied for the first time in this research, was used for measurement of tooth extraction forces. The research has been done in a group of 50 examinees to whom the tooth extraction has been done with lower premolar forceps – forceps »13« and in the control group of 54 examinees in whom the tooth extraction has been done with upper incisive forceps – forceps »1«. The measurement instrument registered the extraction forces values in both types of forceps. There was no difference in any parameters in these two groups except in used pressure. While using the forceps »13«, a significantly lower tooth extraction force was measured than the force measured while using the forceps »1« ($p<0.001$). This means that in clinical work we can already apply noticeably less force using the lower premolar forceps for the extraction of the upper incisors (in the moments of rotation up to 70%). These results are meaningful, because they lead to better and improved instrument solutions and working techniques.

***Key words**: tooth extraction forceps, tooth extraction forces, upper incisors*

Introduction

Forceps are probably the oldest tooth extraction instrument, besides fingers. They were mentioned by Aristotel, Erasistrat, Celsius and Galen among the Romans. First more detalied descriptions of tooth extra- ction forceps can be found in »Chirurgicorum omnium« by Albucasis (936-1013)[1–4]. Throughout the history, the forceps were modified in their appearance and shape[5–8]. The development of dentistry, dental materials and techniques, especially in the last 50 years, has not been followed by the tooth extraction techniques and instruments[9–15].

The reason for this stagnation lies in the fact that tooth extraction forces could not be measured and expressed by mathematical relations. Extraction forces were expressed as strong, mild or moderate. In his work, Malden only qualitatively describes rotation forces and tooth dislocation[9].

A similar research was carried out in 1972 at School of Dentistry of Tokyo. It should be mentioned that the examination was done »in vitro«. The extracted teeth were put in a solid mass. Imitating the tooth extraction movements, the appearing forces were followed and on the basis of electric potential difference they were registered on a graph paper. The disadvantage of this research is the fact that in normal conditions there is an elastic connection between the teeth and bones (our research) while in this research this connection is rigid, and therefore decreases the importance and the result of work[15].

In 1980 Ojala and collaborators carried out the first research on patients and went ahead with the first tooth extraction measurement. They looked into the magnitude and acting times of the rocking moments acting in buccal and lingual direction by forceps. The main flaw was the fact that they didn't measure the surface of teeth, which is directly connected to the resistance which a tooth puts up during the extraction. They measured size of the shift and time used up to carry throughout the intervention, which depends considerably on the capability of the operator[16–19].

Measurement of the extraction force in relation to the surface of a tooth, making it as close to natural condi-

Received for publication August 28, 2005

tions and using surface and force as mathematical magnitudes gives the scientific quality to this study.

Due to the problems appearing in tooth extraction by usual instruments and methods, there was a need to evaluate the present forceps and extraction techniques in order to improve the working efficacy and simplify surgical procedures.

This work's aim was to measure the mechanical forces used in upper incisors extraction by lower premolar forceps and upper incisive forceps and suggest the most adequate tooth extraction forceps based on the efficacy of teeth extraction forceps.

Materials

The research involved 104 examinees operated by the author during the period between 2003–2004 with the standard methods for extraction of upper incisors. All of them were referred to the Department of Oral and Maxillofacial Surgery of The University Hospital Rijeka, due to inability of tooth extraction in primary care units. Two groups were formed at random: the examined group of 50 examinees to whom the upper incisors extraction were done by lower premolar forceps – number »13« and the control group of 54 examinees to whom the extractions were done by forceps for upper incisive teeth – number »1«.

All the examinees became acquainted with the kind and duration of the procedure, type of anesthetic, length of recovery, possible complications that might occure and they gave their consent, according to ethical standards approved by The University Hospital Rijeka and Medical Faculty of Rijeka.

Teeth

The research involved only teeth of normal mobility level (level 1). The bone density, the quality of the supporting bone and number of periodontal fibers attaching the tooth, can not be established precisely without sophisticated methods, so the condition of supporting tooth tissue was established by mobility degree.

Before extraction we made x-rays to avoid any abnormality in root shape such as curvature, bulbosity and hypercementosis. Extraction resulted in fractured roots we treated as a complication during the extraction, and those results will be published in an article dealing with root fracture forces caused by too much force applied on the forceps handles.

Methods

Measurement of pressure forces

In this paper extraction forces of upper incisive teeth were measured by a measuring instrument known as »Instrument for pressure and rotation measurement«. It was patented in 2003 in conformity with patent request no. HR P20030692A, in the register of patents of the Office for Intellectual Property[20]. According to international classification it was classified as G 01 D 21/00. The measuring instrument (Figure 1) functions in the way that three-part air bags-silicone rubber (number 2) are pulled by the handles of forceps (number 1) through foreseen cylindrical transitory holes (number 3). Then, with tooth extraction forceps we measure the pressure and rotation forces in the way that six air bags on two handles are connected (number 4) with three manometers (number 5). With the system of automatic manometer blocking we can measure the maximal pressure force used on manometer 2. The force used in rotation on the left and on the right is read on manometers 1 and 3. Obtained values measured on manometers are expressed in bars, and they express the pressure force on the forceps handles. The pressure forces were measured on the handles on three manometers which were calibrated up to 1 bar. Manometers 1 and 3 measured left and right rotation, and manometer 2 measured tooth dislocation.

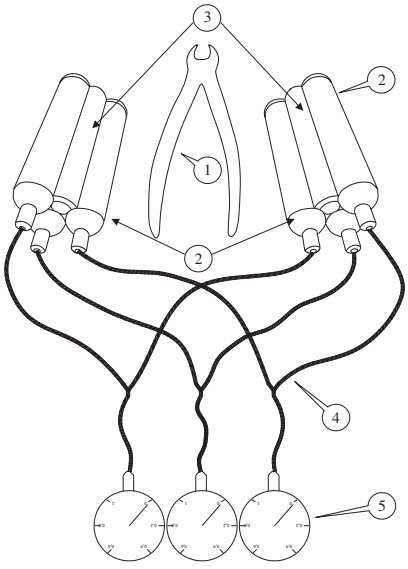

Fig. 1. Instrument for pressure and rotation measurement. 1 – forceps, 2 – three-part air bags-silicone rubber, 3 – cylindric transitory holes, 4 – connecting tubes, 5 – manometers.

Measurement of tooth surface

The extracted teeth had one root in order to simplify measurement. The surface of the tooth's root is directly connected with the extraction force due to the resistance which appears in tooth extraction.

The root of the extracted tooth was measured on five different places with sliding scale. The tooth surface was established by measured dimensions, inserting the values in the formula for calculation of irregular cone surface.

Statistical analysis

The normality of age data distribution was tested using Kolmogorov – Smirinov test. Since the distribution

was not normal, we used the Mann-Whitney test to determine the differences in age among the tested groups. Pearson's χ^2 test was performed in order to test the differences in gender between the tested groups. One-way ANOVA was used to compare the differences in used pressure between groups. We computed the correlation matrix, using Pearson's product-moment correlation for analysis of correlations between used pressure with the extraction forceps and tooth surface.

All statistical analyses were performed with Statistica for Windows (release 6.1., StaSoft. Inc., Tulsa, OK, USA). The level of statistical significance was set at 0.05.

Results

The average total pressure (X±SD) determined by upper incisive forceps-number »1« was significantly higher than the one determined by lower premolar forceps – number »13« 1.11±0.28 bar vs. 0.66±0.19 bar, p<0.001 (Table 1).

There was no difference in gender between control group and examined group; p=0.737 (Table 1). Also, there was no difference between control group and examined group regarding to age, p=0.327, and the teeth surfaces, p=0.071 (Table 1).

Preassures measured by manometer 1 – left rotation movements, manometer 2 – dislocation movements and manometer 3 – right rotation movements, according to type of forceps were shown in Table 2.

The pressure value determined by manometer 1 in control group-forceps »1«, was significantly higher than in examined group-forceps »13«, 0.33±0.1 bar vs. 0.20± 0.08, p<0.001 (Table 2). Pressures determined by manometer 2 and manometer 3 in control group-forceps »1«, were also related to significantly higher values then pressures determined in examined group-forceps »13« (Table2).

In both groups Pearson's coefficient correlations were positive and significant. In control group-forceps »1« (r=0.564, p<0.001). In examined group forceps »13« (r= 0.298, p=0.036).

With the increase of tooth surface, the used pressure significantly increased.

Pearson's coefficient correlation for pressure determined by manometer 2 in examined group- forceps »13«, was low and it wasn't significant (r=0.0221, p=0.123). But, coefficient correlation in control group-forceps »1«, was founded significant (r=0.563, p<0.001), indicating that teeth surfaces influenced on the pressure.

In the examined group-forceps »13«, with the increase of teeth surfaces, the used pressure increased, but not significantly (r=0.202, p=0.161).

In the control group-forceps »1«, with the increase of teeth surfaces, the used pressure significantly increased (r=0.549, p<0.001).

Discussion

For the first time in this paper tooth extraction forces were measured »in vivo» and compared to tooth surface. The total pressure applied on forceps «13« – lower premolar was statistically lower than the total pressure applied on forceps »1« – upper incisive (0.66 vs. 1.11 bar). The mean surface of the teeth extracted with the forceps »13« is not significantly different than the mean surface of the teeth extracted with the forceps »1« (13.71 mm^2 vs.

TABLE 1
DEMOGRAPHIC CHARACTERISTICS, MEAN TEETH SURFACES AND OBTAINED PRESSURE REGARDING TO TYPE OF FORCEPS

Variable	Control group Forceps »1«	Examined group Forceps »13«	p
	Number of subjects	Number of subjects	
Gender			
male	32	28	0.737
female	22	22	
Age, median, (range)	57 (28–79)	52 (12–76)	0.327
Tooth surface (X±SD, mm^2)	14.47±2.25	13.71±2.03	0.071
Pressure (X±SD, bar)	1.11±0.28	0.66±0.19	<0.001

TABLE 2
RELATIONSHIP BETWEEN MEASURED PREASSURE ACCORDING TO MANOMETER 1, 2, 3 AND TYPE OF FORCEPS

Variable	Control group Forceps »1« (X±SD)	Examined group Forceps »13« (X±SD)	Statistics	
			F	p
Manometer 1 (bar)	0.33±0.10	0.20±0.08	58.38	<0.001
Manometer 2 (bar)	0.47±0.12	0.29±0.09	72.49	<0.001
Manometer 3 (bar)	0.31±0.09	0.17±0.11	53.89	<0.001

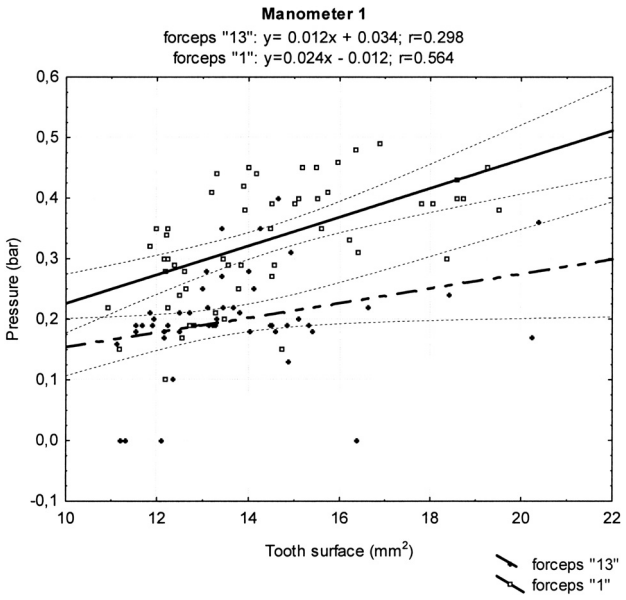

Fig. 2. Correlation between the tooth surface and measured pressure with manometer 1 regarding to forceps »1« and »13«.

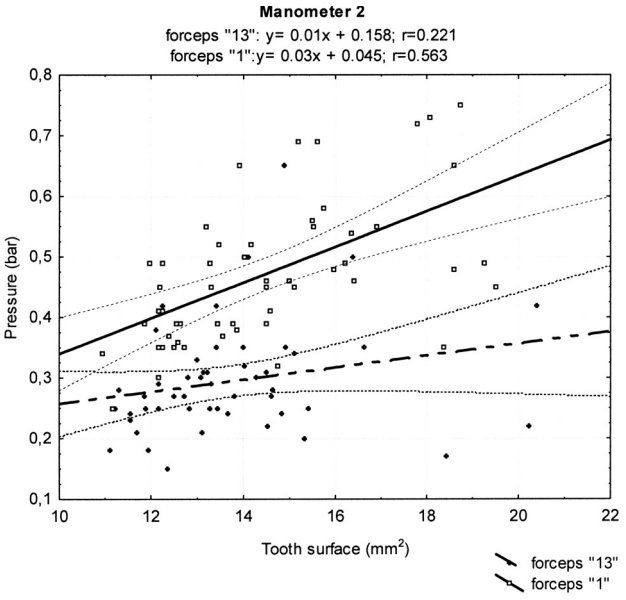

Fig. 3. Correlation between the tooth surface and the measured pressure with manometer 2 regarding to forceps »1« and »13«.

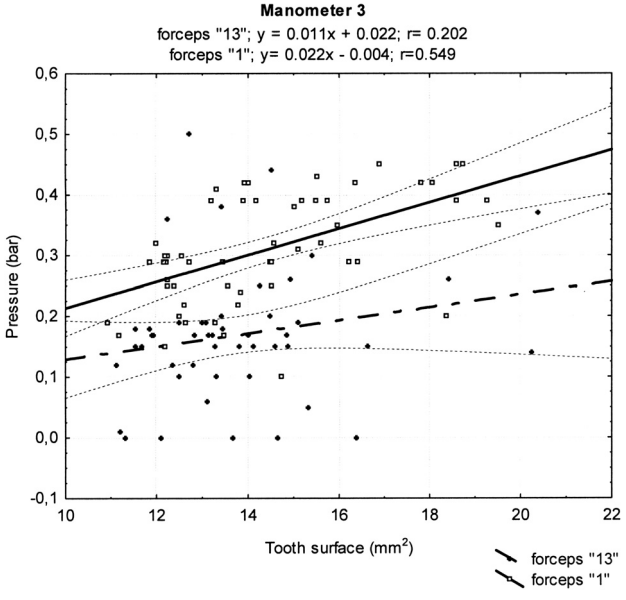

Fig. 4. Correlation between tooth surface and measured pressure with manometer 3 regarding to forceps »1« and »13«.

14.47 mm[2]). An additional examination was done by measuring the pressure force of each manometer separately, in single forceps. In the control group – forceps »1«, with the increase of tooth surface, the used pressure also increased ($p<0.05$). It proves that in the forceps »1« – the upper incisive, the rotation movements – manometers 1 and 3 are equally present as the dislocation movements – manometer 2. In the examined group, where lower premolar forceps were used in teeth extractions – forceps »13«, there were a significant difference between the movements of rotation and dislocation. A significant pressure increase with the increase of tooth surface was measured only with manometer 1 ($p<0.5$). On manometers 2 and 3 the increased pressure in relation to the increased tooth surface was positive, that means that the pressure got stronger with increased tooth surface. However, this connection was not statistically significant ($p>0.05$). It indicates that left rotation (manometer 1) is a predominant movement-collagen fibers in the relation tooth-bone are broken. Dislocation (manometer 2) and rotation to the reverse side (manometer 3) are not so strong, because the first rotation caused the destruction of most collagen fibers and the strength of teeth was significantly impaired.

In the conclusion we emphasize that in our research for the first time mechanical forces, used in tooth extraction, were measured »in vivo« with the »Instrument for pressure and rotation measurement«. On the basis of the effectiveness of the tooth extraction forceps, we proved that the pressure while using lower premolar forceps in upper incisors extraction is significantly lower than in tooth extraction done with upper incisive forceps. It is important to mention that significantly lower force (in the moment of rotation up to 70%) leads to the same effect, but in some situations when the root extraction is not possible with usual forceps for upper roots we avoid surgical treatment of the tooth root removal.

REFERENCES

1. PIERLEONI, P., L. BOSSINI, P. BOSSINI, Minerva Stomatol., 34 (1985) 595. — 2. CLARKE, J., J. Hist. Dent., 47 (1999) 11. — 3. ATKINSON, H., Aust. Dent. J., 47 (2002) 90. — 4. SIGRON, G., Schweiz. Monatsschr. Zahnmed., 95 (1985) 587. — 5. FOLEY, G., J. Am. Coll. Dent., 51 (1984) 22. — 6. DE GUZMAN, P., Bull. Hist. Dent., 33 (1985) 90. — 7. ROSENTAL, E., J. Hist. Dent., 48 (2000) 60. — 8. FEE, E., T. BROWN, J. LAZARUS, P. THEERMAN, Am. J. Public Health, 92 (2002) 35. — 9. MALDEN, N., Dent. Update, 28 (2001) 41. — 10. HYDE, T., Br. Dent. J., 179 (1995) 26. — 11. LISENKOV, V., I. DEMIDOVA, Stomatologia, 77 (1998) 12. — 12. JAVAHERI, D., J. GARIBALDI, J. Am. Dent. Assoc., 128 (1997) 751. — 13. LEONARD, M., Dent. Today, 2 (2002) 38. — 14. MAMEDOVA, L., Probl. Sotsialnoi Gig. Istor. Med., 1 (2000) 62. — 15. KAWAMOTO, T., Shikwa Gakuho., 73 (1973) 59. — 16. LEHTINEN, R., T. OJALA, Int. J. Oral Surg., 9 (1980) 377. — 17. OJALA, T., Int. J. Oral Surg., 9 (1980) 367. — 18. OJALA, T., R. LEHTINEN, Int. J. Oral Surg., 9 (1980) 373. — 19. LEHTINEN, R., T. OJALA, Int. J. Oral Maxillofac. Surg., 15 (1986) 444. — 20. AHEL, V., M. ŠARAČEVIĆ, Patent No. HR P20030692A, (Državni zavod za intelektualno vlasništvo, Zagreb, 2003).

V. Ahel

Department of Oral and Maxillofacial Surgery, University Hospital Rijeka, T. Strižića 3, 51000 Rijeka, Croatia
e-mail: vladimir.ahel1@ri.htnet.hr

MJERENJE SILA EKSTRAKCIJE GORNJIH INCIZIVA

SAŽETAK

U ovom radu primijenjena je nova metoda za mjerenje sila ekstrakcije gornjih inciziva. Istraživanje je provedeno u skupini od 50 ispitanika kod kojih je ekstrakcija zuba izvršena donjim premolarnim kliještima – kliješta »13«, te u kontrolnoj skupini od 54 ispitanika gdje su za ekstrakciju zuba korištena gornja incizivna kliješta – kliješta »1«. Mjernim instrumentom utvrđivane su vrijednosti sila ekstrakcija za oba tipa kliješta. Pri upotrebi donjih premolarnih kliješta izmjerena je značajno manja sila ekstrakcije od sile izmjerene korištenjem gornjih incizivnih kliješta ($p<0,001$). Drugi proučavani parametri u ove dvije skupine nisu se razlikovali. To ukazuje da u kliničkom radu već sada korištenjem donjih premolarnih kliješta za ekstrakciju gornjih inciziva možemo koristiti značajno manju silu, u momentima rotacije i do 70%. Rezultati ovog istraživanja značajni su jer će unaprijediti postojeće instrumente i tehnike ekstrakcije zuba.