Influence of root canal disinfection with Er.Cr,YSGG laser at 1.5w power on the push-out bond strength of resin sealers

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ABSTRACT

Aims: To confirm the influence of root canal disinfection (RCD) with Er.Cr,YSGG laser at 1.5w power on the push out bond strength (PBS) of obturation using two resin sealers (AH plus and Sealer 26).

Materials and Methods: Sixty single rooted premolars were decoronated, instrumented using Rotary system ProTaper to F3 and divided randomly into groups (n=20): Gp (I) Er.Cr,YSGG laser, Gp (II) Sodium hypochlorite and ethylenediamine tetra-acetic acid (EDTA) and Gp (III) normal saline. Each Gp then subdivided into 2 Gps (n=10)(AH plus and sealer 26). Roots were X horizontally sectioned at three levels in the apical, middle, and cervical thirds of each group. PBS test was performed using digital universal testing machine at speed1mm/min. Mode of failures were evaluated using digital stereomicroscope (40 X).

Results: PBS of canals disinfected by Er.Cr,YSGG and obturated by AH plus was significantly higher than other groups. PBS of obturated canals with sealer 26 after laser disinfection shows significantly higher strength than those treated with NaOCl+EDTA.

Conclusions: This study revealed that Er.Cr,YSGG laser disinfection significantly enhance the PBS of resin sealers.

Key words: Er.Cr,YSGG, Resin sealers, AH plus, Sealer 26.

HOW TO CITE THIS ARTICLE

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INTRODUCTION

Success of endodontic therapy is depending on sufficient shaping, cleaning, and 3D obturation of the canal space. Technique currently used for obturation is obtained with interfusing solid filling material, as gutta-percha in combination with different types of sealers [1].

Several sealers were used in endodontics, which gives an ideal seal between the core materials and radicular walls [2]. Sealer is necessary during obturation and should demonstrate capacity to adhere to dentin such adhesive behavior will result in higher strength of restored tooth, improve good fracture resistance and increased longevity of tooth treated with endodontic [3].

Epoxy resins can penetrate deeper into the microirregularties due to its flowability and long polymerization time, which contribute to increase the interlocking between dentine and sealer [4]. Sealer adhesion is determined by their PBS. This test used to measure the bond between sealer and canal wall [5]. Previous study represented that Er,Cr:YSGG laser has the capacity to disinfect the root canal against the most resistant bacteria that was associated with persistent endodontic infection at 1.5W [6].

Therefore, the purpose of present study was to measure and compare PBS of two resin based sealers (Sealer 26 and AH Plus) to root canal dentin after RCD with Er.Cr,YSGG at 1.5w power. Also, to assess the failures modes on debonded surfaces of these different sealers.

MATERIALS AND METHODS

Sample Preparation:

Sixty extracted premolars with a single canal and completely formed apex were stored in distilled water at 37^{o}C. The crowns were cut at the level of the CEJ to standardize root segments at 14 mm length. After that, K-file size 10 was introduce into the canal to the full working length until it was seen at the apical foramen under digital stereomicroscope at (X 20) (Motic, Taiwan). Then 1 mm was subtracted from this length to evaluate the working length. Then specimens were fixed in a blocks of elastomer impression material of (2*2*2.5cm) dimension. Then specimens were divided randomly into three Gps according to the type of RCD.

GP I: Pro Taper Nickel Titanium Rotary system (Dentsply-Maillefer, Switzerland) was used for instrumentation, using rotary hand piece (Endo-Mate DT, NSK NAKANISHI, INC., JAPAN). The rotation speed was maintained at 250 rpm and torques 3 Nm. Coronal two-thirds of the canal was pre-enlarged using ProTaper Shaping instruments S1 followed by S2 employing a brush cutting action. Both S1 and S2 were then carried sequentially to full working length. Preparation was finished using ProTaper Finishing instruments F1, F2 and F3 in succession [7]. Discarding file after five specimens. Irrigation with normal saline (5 ml) was used after changing each file, and then drying the canal using ProTaper paper points size F3. After that the canals were irradiated with an Er.Cr:YSGG laser, 2.78 μm with radial firing tips (RFT3) that adjusted at 1.5 W, 20 Hz, 10% air flow without water. Specimen was subject to one lasing cycle, which composed five irradiations of 5 s duration with a 20s break in between [6].

For group II: In this group the specimens subjected to similar procedure of canal preparation as those applied in group I utilizing rotary system except that without laser treatment. Sodium hypochlorite (5.25% NaOCl, 5 ml) irrigation was used after each file change. After completion of canal preparation, the canals irrigate with 5 ml 15% (EDTA) to decrease the residual effect of NaOCl on free radical polymerization. Finally the canal rinsed with of 5 ml distilled water. Then drying the canal using ProTaper paper points size F3 [8].

For groupIII: In this group the specimens subjected to similar procedure of canal preparation as describe before in group I except that without laser application and normal saline (5 ml) was used for irrigation after each file changes, then the canal was dried using ProTaper paper points size F3.

Then each Gp was subdivided into two Gps according to the sealer type used (10 specimens on each group) as follow:

Group (I, II, and III) A: AH plus (Dentsply, De Trey GmbH, Germany).
Group (I, II, and III) B: Calcium hydroxide resin based (Sealer 26) (Dentsply, Rio de Janeiro, RJ, Brazil).

For each tooth, the canal filled using a main cone, ProTaper F3 master point which was matched to the final master file size. Sealers were prepared according to manufacturer's instructions, and then introduced into the canal orifices with lentula spiral; also gutta percha cone was coated with the sealer prior to its placement into the canal. After that, composite resin was used to seal coronal and apical sides of the canal to avoid entrance of fluid inside the canal. All specimens were then stored at 37^{o}C for one week to permit the sealer cements to completely set.

Push-out Bond Strength (PBS):

Specimens in all groups were then sectioned perpendicular to their long axis using a mintom (Struers, Denmark) with constant water cooling. Firstly, a 1 mm thickness slices from apical and coronal side of the root was cut and discarded so that to avoid composite resin effect that used for sealing of the specimens, so the length of the specimen became 12 mm. Then each root was section into 3 thirds (coronal, middle, and apical) with 4 mm thickness. After that, 2 mm thickness slice from the cervical part of each third was prepared. Both apical and coronal aspects of each sample were photographed by digital stereomicroscope (X 20) and examined before testing to confirm a round canal shape and that sealer was filled the entire canal space with without voids (Figure 1).

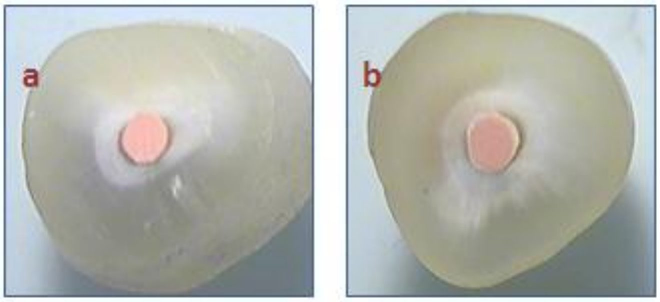

Figure (1): Prepared sample for PBS. (a): Apical aspect. (b): Coronal aspect.

If the canal was not circular in shape or there was any porous in the sealer, it was excluded from the study and replace by another tooth. After that, the specimens were aligned over a 2 mm diameter circular hole along the center of an acrylic block (10 mm-thick and 16 mm diameter). The specimen was fixed in an apical to coronal side for prevention of any interference because tapering of canal during testing. Three cylindrical stainless steel punches were used (1mm, 0.8mm, 0.4mm) for coronal, middle and apical section respectively. The punch was mounted in the upper part of a digital universal testing machine (wp 300 universal material tester, 20 kn, gun thamburg) (Figure 2) and should provide almost complete coverage over the main cone without touching the canal wall. The test was performed at a cross head speed of 0.5 mm/min. The highest value recorded when failure occur was taken as the PBS. The surface area was produced by ½ × (circumference of coronal aspect + circumference of apical aspect) ×thickness [9], in which the circumferences and surface area of apical and coronal canal were measured by Motic Image software connected to digital stereomicroscope. The PBS in Mpa was calculated from force (N) divided by area in mm^2 [9,10].

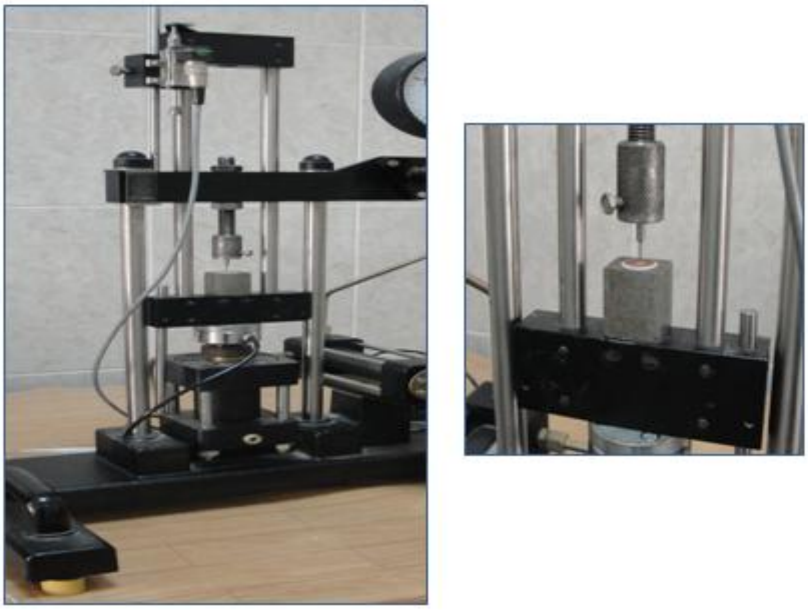

Figure (2): Tested sample fixed on the digital universal testing machine for PBS.

Mode of Failures:

Specimen was viewed on digital stereomicroscope at 40X to reveal the Mode of failure and put into one of the following categories: (1) adhesive (at the sealer/dentin interface), (2) cohesive at sealer, and (3) mixed in both cohesive and adhesive modes.

Statistical Analysis:

One way analysis of variance and Tukey post Hoc multiple range tests ($P \leq 0.05$) were used to detect the differences on PBS among tested groups.

RESULTS

One-way analysis of variance demonstrated significant differences on the PBS among tested groups as shown in (Table 1).

For all regions the result showed that significantly higher PBS in group disinfected by Er.Cr,YSGG than those disinfected by NaOCl+EDTA and normal saline regardless of sealer type ($P < 0.05$). Similar behavior was obtained regarding the sealer type effect after canals filling with AH Plus shows significantly higher PBS than there obturated with sealer 26 as seen in (Table 2).

Table (1): One way analysis of variance for the differences on PBS at different root segments using different RCDs and sealers.

Root Segments	Sum of Squares	Df	Mean Squares	F	P-value*
Coronal Between Groups	30.803	3	10.268	730.300	0.000
Within Groups	0.506	36	0.014		
Total	31.309	39			
Middle Between Groups	30.217	3	10.072	2205.993	0.000
Within Groups	0.164	36	0.005		
Total	30.381	39			
Apical Between Groups	26.925	3	8.975	313.412	0.000
Within Groups	1.031	36	0.029		
Total	27.956	39			

*df=degree of freedom
*P≤0.05 mean significant different exist.

Table (2): Mean PBS among different root canal segments using different RCDs and sealers.

Groups	Root Segments Mean(Mpa)±SD		
	Coronal	Middle	Apical
Er.Cr,YSGG &AH plus	**5.66±0.02 A***	**5.21±0.10 A**	**4.96±0.01 A**
NaOCl+EDTA &AH plus	**4.56±0.08 B**	**4.24±0.02 B**	**4.05±0.12 B**
Er.Cr,YSGG &Sealer 26	**3.78±0.12 C**	**3.41±0.07 C**	**3.20±0.03 C**
NaOCl+EDTA &Sealer 26	**3.35±0.17 D**	**2.93±0.04 D**	**2.84±0.13 D**
Normal Saline &AH plus	**2.81±0.06 E**	**2.73±0.05 E**	**2.69±0.09 E**
Normal Saline &Sealer 26	**2.79±0.08 E**	**2.75±0.07 E**	**2.71±0.07 E**

*The different letters vertically mean significant difference exist.

Failure modes of the different sealers were listed in (Table 3). The most predominate mode of failures for groups obturated using AH Plus was cohesive and mixed only, while those obturated by sealer 26 were adhesive, cohesive and mixed (Figure 3).

Table (3): Failure modes among tested root segments using RCDs and sealers.

Groups	Root Segments	Failure Mode %		
		Adhesive	Cohesive	Mixed
Er.Cr,YSGG &AH plus	**Coronal**	0	40	60
	Middle	0	40	60
	Apical	0	30	70
NaOCl+EDTA &AH plus	**Coronal**	0	20	80
	Middle	0	30	70

	Apical	0	20	80
Er.Cr,YSGG &Sealer 26	**Coronal**	20	20	60
	Middle	30	20	50
	Apical	30	10	60
NaOCl+EDTA &Sealer 26	**Coronal**	30	10	60
	Middle	40	10	50
	Apical	40	10	50
Normal Saline &AH plus	**Coronal**	60	10	30
	Middle	70	20	10
	Apical	70	10	20
Normal Saline &Sealer 26	**Coronal**	80	10	10
	Middle	70	20	10
	Apical	70	10	20

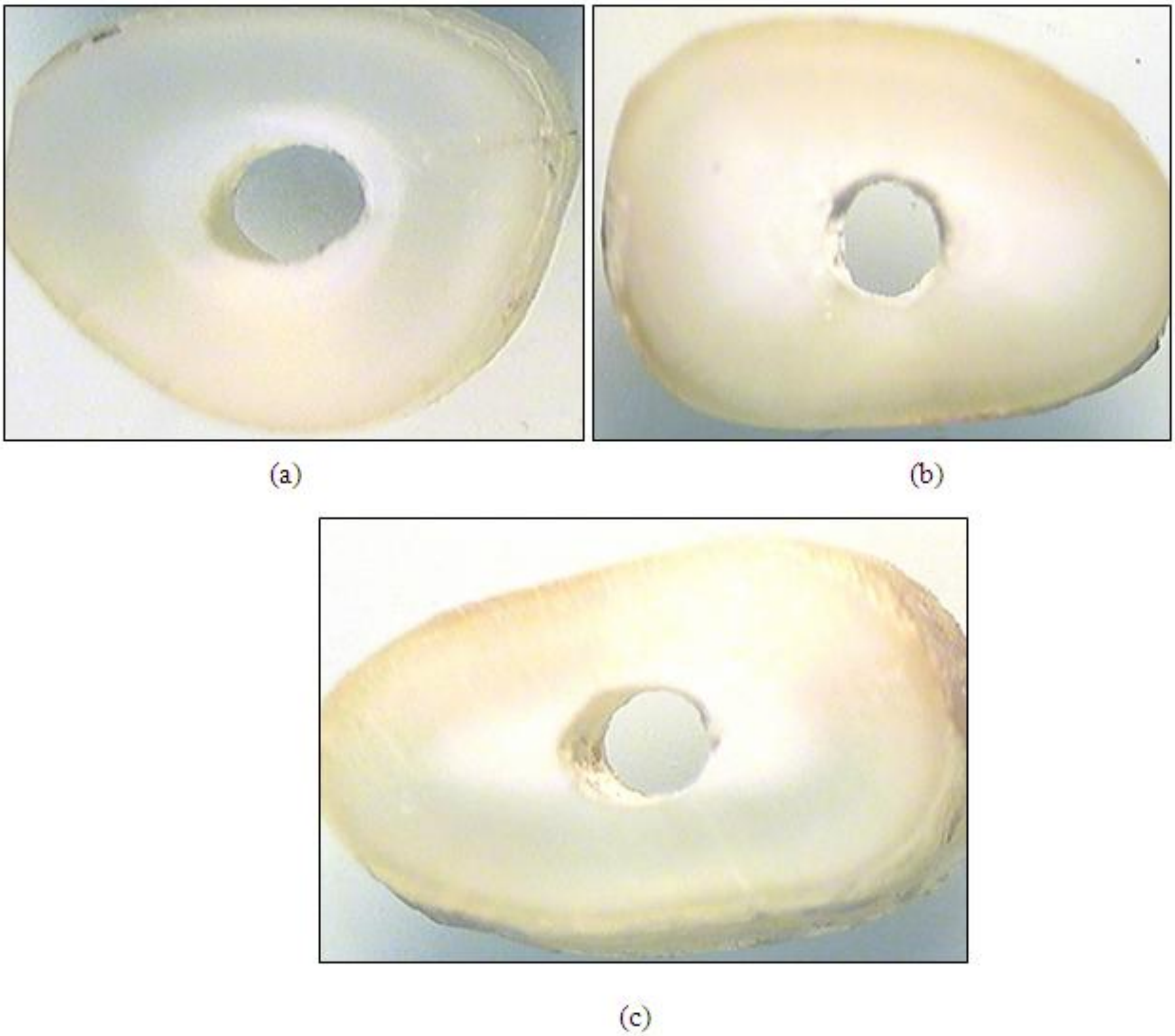

Fig. 3: Different modes of failure: (a) Adhesive failure, (b) Cohesive failure, and (c) Mixed failure.

DISCUSSION

Bonding between the endodontic material and the canal walls is very importance to enhance success of radicular management. Additionally, a homogenous and gap-free interface between canal wall and endodontic material must be achieved to prevent microleakage [11].

The present study demonstrated the influence of Er,Cr:YSGG laser at the power of 1.5W on the PBS of obturation because the previous study reveal that Er,Cr:YSGG laser has good disinfection capacity [6].

In this study slices with 2 mm thickness were used according to Barbizam *et al* [11] who reported slices with 2 mm thickness were preferable for prevention of debonding.

In this experimental study, result found that AH plus shows highly significant PBS than Sealer 26. The superior adhesion of AH Plus to dentin due to its better adaptation into the microirregularities due to long setting time and its creep ability, which enhance the interlocking between root dentin and sealer [12].

Also the present study revealed that the PBS of the AH Plus and Sealer 26 sealers after irradiation with laser were significantly greater than the other groups. This might be due to surface treatment of dentin with different irrigation may cause changing in the structural and chemical composition of human dentin. Optimum adhesion needs perfect contact between the adhesive material and substrate to enhance chemical adhesion and molecular attraction or penetration for micromechanical surface interlocking [13].

Study by Wang *et al* 2005 [14] showed that laser disinfection produce cleaner surfaces when compared with a combination of EDTA and sodium hypochlorite, which could produce a good adaptation of the filling to the root canal walls.

One possible explanation of higher PBS of the sealers to intraradicular all after irradiation of canal with 1.5W power in comparison with those that are not subject to irradiation may be due to structural alteration promoted by laser. Another probable explanation for this result is that the capacity of Er,Cr:YSGG laser for removing the smear layer [15].

Study by *Minas*, *et al*. [16] showed that irradiation of intraradicular space with Er,Cr:YSGG result in smear layer removal, open dentinal tubules, and producing a rougher and clean surface, this might affect PBS. Adhesion between the root canal wall and filling material was influence by alteration of morphology dentine surface at the root canal [17].

The most predominate of failure modes in this study was mixed and cohesive when Er,Cr:YSGG and NaOCl+EDTA were used for disinfection. This may be due to the mechanical properties of the sealers used in present study and also due to the ability of disinfections for smear removing because this layer act as negative factor for canal sealing, because of the interface between root canal walls and the filling material, which decrease the PBS [18]. Therefore, because the previous explained reasons it can be concluded that irradiation with Er,Cr:YSGG laser of the canal produce in highly significant dislodgment resistance of the filling materials.

CONCLUSIONS

The PBS of the material-dentine interface was dependent on the kind of disinfections and sealers used. Disinfection with Er,Cr:YSGG laser at 1.5 w produce in good adaptation of resin sealers to canal dentin than NaOCl+EDTA. AH plus sealer revealed highly significant PBS than sealer 26 in both disinfection protocols (Er,Cr:YSGG and NaOCl+EDTA).

REFERENCES

[1]. Harikumar V, RaviChandra PV, JayaPrada RS, RamKiran D, Jaya NKM, Rajani S, Jyothsna YS. Comparative evaluation of push-out bond strength of three endodontic sealers with and without amoxicillin-An Invitro Study. *JCDR*. 2013;7:23-28.

[2]. Tyagi S, Mishra P, Tyagi P. Evaluation of root canal sealers An insight story. Eur J Gen Den Dent. 2013; 2:199-218.

[3]. Hammad M, Qualtrough A, Silikas N. Effect of new obturating materials on vertical root fracture resistance of endodontically treated teeth. *J Endod.* 2007;33:732-736.

[4]. Carvalho-junior Vl. A comparative study of physicochemical properties of AH plus and epiphany root canal sealants. *Int Endod J*. 2006; 39: 464–471.

[5]. Sousa-Neto MD, Silva Coelho FI, Marchesan MA, Alfredo E, SilvaSousa YT. Ex vivo study of the adhesion of an epoxy-based sealer to human dentine submitted to irradiation with Er:YAG and Nd:YAG lasers. *Int Endod J*. 2005; 38:866-870.

[6]. Njwan F. Recovery rate of E.faecalis After Er,Cr:YSGG laser disinfection of root canals: an Ex- Vivo Study. *Amer J Med Biol Res*. 2014; 2:12-17.

[7]. Hidalgo LRD, Silva LAB, Leoni GB, Mazzi-Chves JF, Carvalho EES, Consolaro A, Sousa-Neto MD. Mechanical Preparation Showed Superior Shaping Ability than Manual Technique in primary Molars-A Micro-Computed Tomography Study. *Braz Dent J*. 2017; 28:453-460.

[8]. Silva AC, Guglielmi C, Meneguzzo DT, Aranha AC, Bombana AC and De Paula Eduardo C. Analysis of permeability and morphology of root canal dentin after Er,Cr:YSGG laser irradiation. *Photomed Laser Surg*. 2010; 28(1):103-108.

[9]. Fayyad DM and Darrag AM. Effect of different irrigating solutions on push out bond strength of resin obturation system. *Cairo Dent J.* 2007;11:149-157.

[10]. Pawińska M, Kierklo A, Tokajuk G, Sidun J. New endodontic obturation systems and their interfacial bond strength with intraradicular dentine – ex vivo studies. *Advances Med Sci*. 2011;56:327-333.

[11]. Babb BR, Loushine RJ, Bryan TE. Bonding of self-adhesive (self-etching) root canal sealers to radicular dentin. *J Endod*. 2009; 35(4):578-582.

[12]. Barbizam JV, Trope M, Teixeira EC, Tanomaru-Filho M, Teixeira FB. Effect of calcium hidroxide intracanal dressing on the bond strength of a resin-based endodontic sealer. *Braz Dent J*. 2011;19:224-227.

[13]. Rahimi M, Jainaen A, Parashos P, Messer HH. Bond of resin-based sealers to root dentin. *J Endod*. 2009; 35(1):121-124.
[14]. Wang X, Sun Y, Kimura Y, Kinoshita J, Ishizaki NT, Matsumoto K. Effects of diode laser irradiation on smear layer removal from root canal walls and apical leakage after obturation. *Photomed Laser Surg*. 2005;23:575-581.
[15]. Suman S, Verma P, Prakash-Tikku A, Bains R, Kumar-Shakya V. A Comparative Evaluation of Smear Layer Removal Using Apical Negative Pressure (Endo Vac), Sonic Irrigation (Endo Activator) and Er,YAG laser –An In Vitro SEM Study. *J Clin Exp Dent*. 2017; 9:e981-7.
[16]. Minas NH, Gutknecht N, Lampert F. In vitro investigation of intra-canal dentine-laser beam interaction aspects: II. Evaluation of ablation zone extent and morphology. *Lasers Med Sci*. 2010;25(6):867-872.
[17]. Giraldez I, Ceballos L, Garrido MA, Rodriguez J. Early hardness of self-adhesive resin cements cured under indirect resin composite restorations. *J Esth Rest Dent*. 2011;23(2):116-124.
[18]. Jahan KM R, Hossain M, Nakamura Y, Yoshishige Y, Kinoshita J, Matsumoto K. "An assessment following root canal preparation by Er,Cr:YSGG laser irradiation in straight and curved roots, in vitro," *Lasers Med Sci*, 2006;21(4):229–234.