

SOME HISTORICAL MUSINGS ON TOOTH/ROOT RESORPTION

Diş ve Kök Rezorpsiyonu Üzerine Tarihsel Derin Düşünceler

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ABSTRACT

Contemporarily, the ravages of tooth resorption are seen daily around the world. While some teeth can be retained many are lost to this process. Although many types of resorptive processes have been identified, the etiological factors involved in this malady are not often clear and both speculation as to its source and clinical management have received a great deal of empirical explanations and directives, respectively. However, this was not always the case, as the nature of tooth resorption, as is known today, was not really addressed in a significant manner until the mid-1970s. In fact, when first identified as a problem in the early 1800s, the term resorption did not even exist and the process was poorly understood. This historical review of tooth resorption will trace the evolution of some of our ideas about this malady, identifying both the concepts and personalities involved in this evolution.

Keywords: Absorption; periodontal ligament; replantation; resorption; transplantation

ÖZ

Günümüzde, diş rezorpsiyonu kaynaklı tahribat dünyanın her yerinde ve her gün görülmektedir. Rezorpsiyon süreci sonucunda bazı dişler kurtarılabilirken, pek çoğu ise kaybedilmektedir. Birçok rezorpsiyon süreci tipi belirlenmiş olmasına rağmen, bu hastalığın etiyolojik etmenleri genellikle net değildir. Kaynağına ve klinik uygulamalara yönelik çok çeşitli ampirik açıklamalar ve yöntemler üretilmiştir. Bugünkü bilinen anlamıyla diş rezorpsiyonu, 1970'lerin ortalarına kadar ciddi olarak ele alınmamıştır. Aslında bu durum ilk kez 1800'lerin başında bir sorun olarak tespit edildiğinde, rezorpsiyon terimi dahi ortada yoktu ve süreç de çok iyi anlaşılmış değildi. Diş rezorpsiyonuyla ilgili bu tarihsel derleme, ilgili kavram ve şahsiyetler de ele alınarak, bu hastalığa dair fikirlerimizin nasıl geliştiğini ortaya koymaktadır.

Anahtar kelimeler: Absorpsiyon; periodontal ligament; replantasyon; rezorpsiyon; transplantasyon



Introduction

Our predecessors readily identified the destruction of tooth structure that was due to oral disease in the early 1800s; however, their grasp of two significant concepts and their distinct differentiating characteristics were poorly understood. These were **absorption vs. resorption**.

Absorption

1. *Biology* The movement of a substance, such as a liquid or solute, across a cell membrane by means of diffusion or osmosis.

2. *Chemistry* The process by which one substance, such as a solid or liquid takes up another substance, such as a liquid or gas, through minute pores or spaces between its molecules. A paper towel takes up water, and water takes up carbon dioxide, by absorption.

Resorption

The organic process in which the substance of some differentiated structure that has been produced by the body undergoes lysis and assimilation - a process occurring in living organisms.

As early as 1829, Bell (1) recognized the presence of both external and internal “absorptive” defects. In his treatise on the anatomy, physiology and diseases of teeth, he not only detailed his observations but also noted the impact that this process had on the alveolar bone. In his writings however, often times bone and tooth structure were used interchangeably.

External absorption

“On the removal of a tooth under such circumstances (diseased), the root is found to be much blackened, irregular absorption has taken place on every part of it; and, generally, from the exposure of the root to the saliva, by the absorption of the alveolar process, it is covered with small scattered spots, of hard, dark-coloured tartar...as soon as its source of vitality is cut off by the destruction of the membrane, the progress of gangrene is arrested, and the root becomes exposed to that gradual destruction only, which is effected, on the one hand, by the action of the absorbents of the alveolar periosteum, in contact with it; and on the other, by the agency of heat and moisture externally. The method by which these dead

and useless roots are at length thrown off, is curious. Not only does the exposed surface gradually decay by the saliva constantly acting upon it, and absorption at its extremity continually diminish its substance, but a deposition of bone takes place at the bottom of the alveolar cavity, whilst the alveolar process and gum are also absorbed, until at length the root is either loosened and comes out, or is found lying horizontally upon the gum in which it remains partially imbedded... the matter, by its pressure, produces absorption in the parietes of the cavity, and at length finds an outlet by this means at the extremity of the root, the foramen of which is very greatly enlarged. The pulp has by this time become partially absorbed, and the remaining portion having mortified, the tooth also loses its vitality, and gradually assumes a darkish hue” (1).

Internal Absorption

“I have already alluded, when treating of the vitality and organization of the teeth, to a case, the only one I believe on record, in which a formation of pus, with corresponding absorption of part of the bone took place, in the very substance of the crown of the tooth. I have before endeavored to deduce from this remarkable fact the support which it affords to the doctrine in question, and shall now content myself with a detail of the case. Mr. S., a medical gentleman, had long been suffering extreme pain in the right side of the lower jaw, apparently produced by the second molar tooth, which, however, had no external marks of disease. After a time, inflammation took place in the periosteum of the root, and the tooth was in a measure loosened. As it now became evident that the cause of the pain, which still continued to the most excruciating degree, was produced by this tooth, it was extracted; and as no diseased appearance was found on its surface, I sawed it as under at the crown, and found a cavity in the solid bony structure, perfectly circumscribed; the surrounding bone being white, and of a healthy and sound texture. Not the slightest appearance of disease existed in any other part of the tooth, excepting that from the inflammation, which had so long existed, the membrane had also begun to suppurate. In this case then, it appears that inflammation had occurred from some local cause in the bone of the tooth...” (1).

The concept of absorption was perpetuated during the middle of the 19th century, with Bates (2) discussing the absorption process in 1856. However, it was Sir John Tomes (Figure 1) who made

a remarkable and meaningful observation when he encountered a case of “absorption” in permanent teeth. He discussed his case in his text, *A System of Dental Surgery* in 1859 (3).

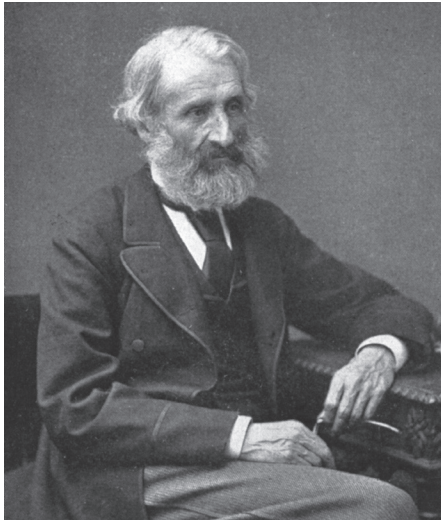


Figure 1. John Tomes (reprinted from the public domain).

“In a patient of my own, an upper central incisor, at the age of fifty, became suddenly loose and painful. It was subsequently found that the one side of the root had been removed by absorption, the process having been arrested when the walls of the pulp-cavity were reached, leaving the pulp perfectly encased in a thin tube of dentine. But for the supervention of inflammation, followed by the secretion of pus, it is probable that in this, as in the preceding cases, the whole of the root would have been removed. The fact that the walls of the pulp-cavity resisted the absorbent action with greater force than any other part of the dentine, accords with what we may observe takes place in a limited degree in temporary teeth. It is probable that the presence of the pulp gives this power of resistance...” (Figures 2 - 4).



Figure 2. Tomes’ description of the dental pulp remaining perfectly encased in a tube of dentin (reprinted from Tomes J. *A System of Dental Surgery*. Philadelphia: Lindsay and Blakiston, 1859).



Figure 3. Contemporary clinical picture depicting exactly what Tomes observed following removal of the soft invasive tissue. Note the pink non-mineralized dentin that is surrounding the root canal & pulp. Also note the area of hemorrhage at the top of the canal (around the 1:00 o’clock position) that appears to red and bleeding. This represents an area where the invasive resorbing tissue is still present working its way through the mineralized dentin. Failure to remove this in its entirety will result in a continued resorptive process if in contact with living tissue.

Tomes’ observation that the pulp may have stopped the spread of the “absorptive process” indicated minimal understanding as to the nature of the process and its affinity for mineralized tissue (dentine) as opposed to non-mineralized tissue (predentine).

W. H. Rollins (4) (Figure 5) discussed the process of “absorption” in response to the practice of replantation and transplantation that were popular in the late 1800s. In doing so he attempted to detail the cellular mechanisms involved.

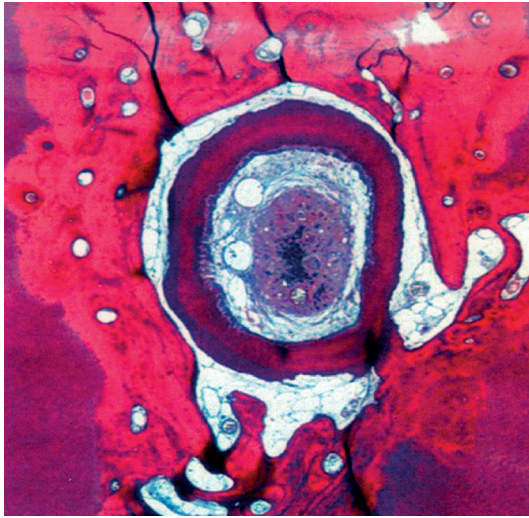


Figure 4. Histological section of the ingrowth of bone into a tooth around the dental pulp that is encased in a pre-dentin matrix.



Figure 5. WH Rollins (reprinted with permission from the American Academy of Oral and Maxillofacial Radiology).

“Dr. William Herbert Rollins, of Boston, states that the microscopical changes wrought by it cannot be distinguished from that absorption seen in deciduous teeth with living pulps, and claims that these lunar excavations seen in teeth with dead pulps are produced, as they are admitted to be in teeth with living pulps, by the agency of living cells... Wherever great cellular activity exists there will be found giant-cells or osteoclasts, sometimes called resorption cells. These giant-cells are found in various diseases wherever there is great cellular activity...they are also found in connection with the resorption of bone in normal development, and in the roots of temporary teeth and other bodies that nature desires to remove. The absorption of the roots of replanted and transplanted teeth, as in the absorption of the roots of healthy deciduous teeth, is due to these giant-cells, or osteoclasts, and is the result of the physiological action of cells stimulated by irritation to increased cellular activity.” (5) (Figure 6).

A further delineation of the process of absorption and repair can be seen in (Figure 7) from Tomes and Nowell in 1906 (6), depicting drawings of the hollowed out lacuna due to dentinoclastic action followed by the deposition of new cementum. The techniques of implantation were referred to as Younger’s Operations and usually consisted of extracting a tooth from one individual and placing it into another (7). In many cases the alveolar socket had to be reworked to enable the transplant, thereby destroying the retained periodontal fibers in the alveolar bone. The destructive “absorptive” process was seen commonly with these types of replantations in the 18th and 19th centuries(8-12). However, Rollins ...”regarded the operation as valuable; but the chief difficulty is, to get teeth which I feel sure are from the mouths of healthy persons. I have implanted only fresh teeth, because I consider their use more likely to result in success.” (13). Two preferred treatments during this time frame were to either boil the extracted tooth to eradicate any disease process in the tooth (caries) or to scrape all the debris from the root prior to replantation (8), which would occupy 30-60 mins and destroy the essential periodontal ligament and its cells. Younger (7) Hunter (8) ultimately reached the clinical conclusion that just maybe the periodontal ligament was essential to protect the tooth. Wadsworth in 1876 (14) identified the crucial nature of the periodontal ligament (*periosteum*) and its need to be retained, lest the tooth undergo absorption;

“I look upon any cutting, or even scratching or bruising, as so many wounds injure and render less certain the result; and every portion of periosteum

remaining on the tooth should be carefully encouraged to remain, as it is of vital importance.” (14).

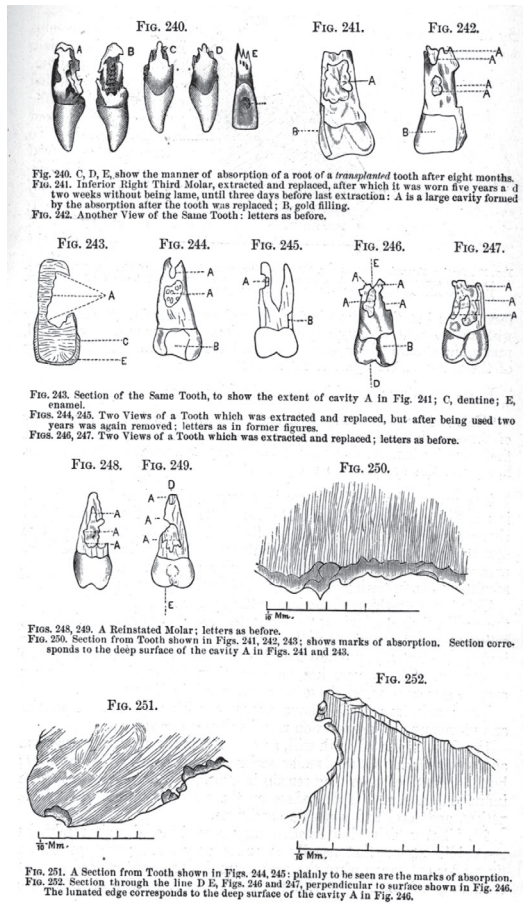


Figure 6. Diagram depicting the activity of the clastic cells on dentin (reprinted from Litch WF. *The American System of Dentistry, Part I, Philadelphia, Lea Brothers & Co. 1887*).

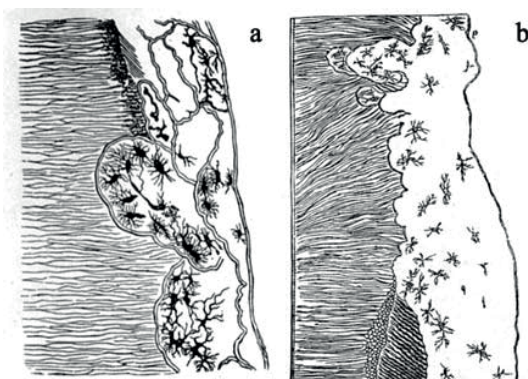


Figure 7. Diagram depicting the delineation of the processes of absorption and repair (reprinted from Tomes CS, Nowell WS. *A System of Dental Surgery. London: J & A Churchill, 1906*).

Needless to say the procedures that involved the destruction of the periodontal ligament encouraged the “absorption” process. In the late 1881 W.F. Thompson (15) presented a lengthy treatise on replantation before the International Medical Congress. He focused on the pericemental tissues “as upon the condition of this tissue replantation is wholly dependent for its success”. Further, more definitive animal studies by Fredel in 1887 (16) and Scheff in 1890 (17) began to address the role of the periodontal ligament in the success of replantation and the sequelae of the observed “absorption” process following replantation. Fredel noted in dog studies that the absorptive phenomenon did not occur in teeth protected by the periosteum (periodontal ligament - PDL) and that it was essential to obtain reunion of the tooth in the alveolus. Moreover, when a portion of the PDL was destroyed, absorption began. There still remained, however, the controversy among clinicians and authors of using fresh teeth vs. dried teeth to prevent the “absorptive” process.

From the late 1800s to approximately 1920, the use of the term “absorption” was still favored by most clinicians and academicians, however some used both terms absorption and resorption somewhat interchangeably. Within his multitude of publications, Dr. John P. Buckley used both absorption and resorption (18). Becks and Marshall (19) met the challenge of the terminology head on with their 1922 publication *Resorption or Absorption?*

“From a review of the dental literature dealing with the clinical and histologic study of the disappearance of hard substances in the organism, it becomes apparent that there is little uniformity in the use of technical terms. This is especially true in regard to the words ‘resorption’ and ‘absorption.’ ‘Resorption’ is preferred not only in the field of general medicine in this country, but is also used in the international dental literature to designate a disappearance of hard substances anywhere in the body. In contrast to this, the dental literature in the United States of America frequently uses this term only in describing the disappearance at the apical end of the roots of deciduous teeth, while the same process in permanent teeth is called ‘absorption.’ Many dental authors use both terms indiscriminately.” (19).

The authors proceeded to survey key authors and investigators, obtaining a wide variety of responses. (Table 1) The rationale for the individual author’s choices however, was not recorded. Interestingly, the authors of this survey could not completely agree with each other in their choices of terminology.

Table 1. Incidence of Usage of Terms - Absorption & Resorption Among Key Authors.

Author	Deciduous Teeth		Permanent Teeth		Bone	
	Absorption	Resorption	Absorption	Resorption	Absorption	Resorption
Anthony LP		+		+		+
Tomes J	+		+		+	
Smale & Colyer	+		+			
Bödecker CFW	+					
Broomell IN		+				
Tomes CS	+		+			
Black GV	+		+		+	
Hopewell-Smith A	+		+		+	
Marshall JS		+		+		+
Noyes & Thomas	+		+		+	
Lischer BE		+		+		+
McCoy JD	Indiscriminate use					
Merritt AH						+
Stillman PR McCall JA					+	
Becks H				+		+
Marshall JA		+	+		+	

The characterization of the absorption process was deemed to be due to a certain degree of malnutrition by Marshall (20), noting that absorptions of tooth structure occurring near the apices of permanent teeth are found more frequently in animals that have been

maintained on a diet low in Vitamin A, along with a decrease in lacunar repair via osteocementum. Eight years later Marshall seemed to be more focused on the concept of “resorption” as opposed to “absorption.” (21) (Figure 8)

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ORIGINAL ARTICLES

THE CLASSIFICATION, ETIOLOGY, DIAGNOSIS, PROGNOSIS AND TREATMENT OF RADICULAR RESORPTION OF TEETH*

JOHN ALBERT MARSHALL, D.D.S., PH.D., SAN FRANCISCO, CALIF.

Figure 8. Photograph of Marshall's famous article that discussed the full ramifications of the resorption process as determined in 1934 (reprinted from Marshall JA. The classification, etiology, diagnosis, prognosis and treatment of radicular resorption of teeth. *Int J Orthodon Dent Children* 1934;20:731-749).

What was interesting during this time period was the conflict amongst clinicians, especially the orthodontists as to whether or not tooth movement

caused - root “resorption.” (Note now the change in terminology) However, a major flaw in the ongoing argument pertinent to both philosophies

was the accurate radiographic documentation and interpretation of the findings. Not only was there a lack of consensus, but also when it came to the permanent teeth, the term “resorption” was commonly used, which apparently had been used first by Broomell already in 1898, but certainly not adopted as the term of choice by the dental community at large (22).

“Dr. Broomell was the first person to be given credit for using the term ‘resorption’ when referring to roots of permanent teeth, this was in 1898. Previously the term absorption had been used entirely, and for 30 years the two words were used and confusion of ideas existed.” (22)

In the early 1930s key individuals who codified a global approach to this dilemma of “absorption” vs. resorption were Gottlieb & Orban (23) and Kronfeld (24). Gottlieb & Orban published a text that dealt primarily with resorption during orthodontia (23), going into great radiographic and histologic detail regarding the “resorptive” process. (Figure 9) While focusing on discussing the “absorbent organ”, referring to the natural destruction of the primary tooth root during permanent tooth eruption, Kronfeld went into depth on the concept of resorption detailing its presence, etiologies and nuances in occlusal trauma, idiopathic entities, deciduous teeth, the role of the dental pulp, impacted teeth, radiographic assessments, in pulpless teeth, in replanted teeth, due to tumors, its presence in orthodontia and its role in cemental repair. (Figure 10)

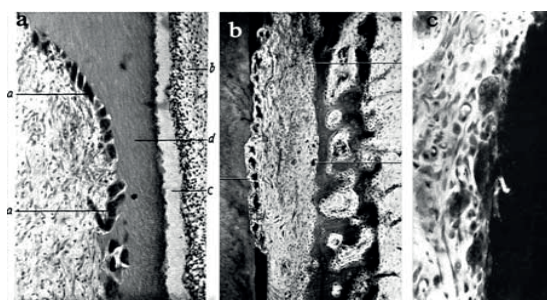


Figure 9. Three photomicrographs detailing Gottlieb’s and Orban’s work on the resorptive process in animals during orthodontic tooth movement. In each picture, **a, b and c**, clastic cells in various numbers can be seen along the root structure and bone that depict varying degrees of root destruction. (reprinted from Gottlieb B, Orban B. *Die Veränderungen der Gewebe bei übermäßiger Beanspruchung der Zähne*. Leipzig: Georg Thieme Verlag, 1931).

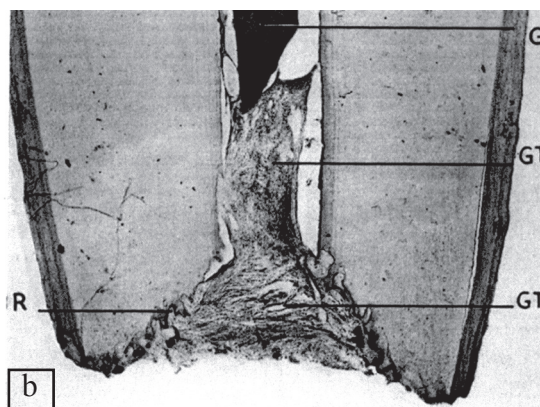
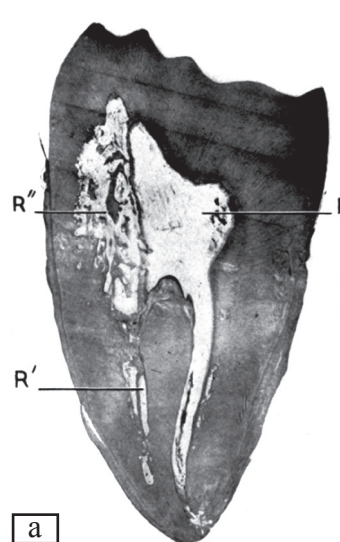


Figure 10. Picture depicting two of Kronfeld’s areas for he defines the resorption process. **a**, Apical resorption due to inflammation in the root canal; **and b**, an invasive type of external resorption into the coronal and radicular pulp space. (reprinted from Kronfeld R. *Histopathology of the Teeth and Their Surrounding Structures*. Philadelphia: Lea & Febiger, 1933).

As dentistry progressed through the 1940s into the 1960s, little attention was paid to the resorptive process other than to either condemn teeth that exhibited resorption. If resorption was evident in a tooth that had a root canal procedure, it may have been subjected to a mere root-end resection, which in many cases ended up also condemning the tooth due to failure to manage the root canal itself either through a nonsurgical revision or a surgically placed root-end filling. Sadly, resorption was viewed as both a disease and an etiology. Stalwart authors during this time period, such as Prinz, Grossman, Coolidge, Healey, Sommer, Ostrander and Crowley did not address the issue of resorption, or gave it mere lip service in

their widely accepted publications. Even Ingle in 1965 (25) only alluded to idiopathic types of resorption, both internal and external. However, in 1963 Penick (26) provided guidelines for the clinical management of root resorption and in 1973 the American Association of Endodontists (27) chose to define resorption, root resorption, internal and external resorption finally bringing to the forefront this malady and its challenges. In 1974 Frank (28) addressed more thoroughly apical and internal resorption, especially in the clinical management of such. Possibly the first full-fledged treatise on resorption and its detailed management was presented in a chapter on *Root Resorption* by Chivian in 1976 (29).

Conclusion

Presently there are a plethora of articles and chapters that address the terminology for the different types of resorption, the biologic processes involved, the radiographic assessment especially using CBCT (Figure 11), management considerations and outcomes. One thing for sure, the term resorption is here to stay, as the confusion regarding the proper terminology has been resolved. However, another issue was not so certain, and that was the expression that was and is used commonly by all today - and that is "the treatment of resorption." Ironically, resorption cannot be treated in any form or fashion. All that can be done is to attempt to remove the etiologic factors, which at times are vague, or remove the resorptive tissue, to create a healthy environment and observe for a positive, healing response. Maybe this proffered dilemma will create a challenge for the musings of future generations to resolve over the next 100 years.

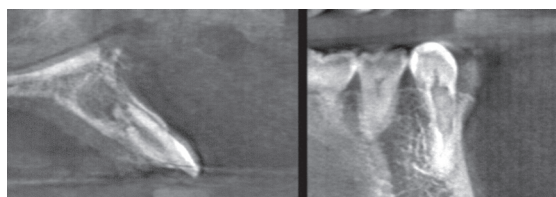


Figure 11. Picture of two CBCT films that show the nature of the resorptive process that cannot be seen with periapical films alone. Left, apical resorption plus palatal resorption that appears to exhibit replacement resorption coming from the palatal cortical plate; Right, evidence of invasive external resorption that has penetrated the root longitudinally but possibly not the pulpal canal. (For a more contemporary and detailed discussion of this type of resorption and that seen in Figure 2. & 3 see Heithersay GS. *Clinical, radiologic and histopathologic features of invasive cervical resorption. Quintessence Int.* 1999;30:27–37.).

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Conflict of interest

None declared.

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