2023

Seventy Years of Commitment to Dental Progress

Loma Linda University School of Dentistry

LOMA LINDA UNIVERSITY

School of Dentistry

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The article is dedicated to Dr. Melvin Lund, the remaining original faculty member.

Leif K. Bakland, DDS'63

Dr. Melvin Lund being congratulated by Dr. Clyde Roggenkamp

Introduction

Seventy years ago, on August 26, 1953, forty-two students enrolled in the inaugural class of the School of Dentistry, Loma Linda University (LLUSD). The university was then known as the College of Medical Evangelists (CME) but later adopted the name Loma Linda University in 1961. The school's first dean, Dr. M. Webster Prince, welcomed the all-male class of students. At that time in the United States, dentistry was not a frequent career choice for women interested in health care. The first LLUSD female dental student entered the class that began in 1959.

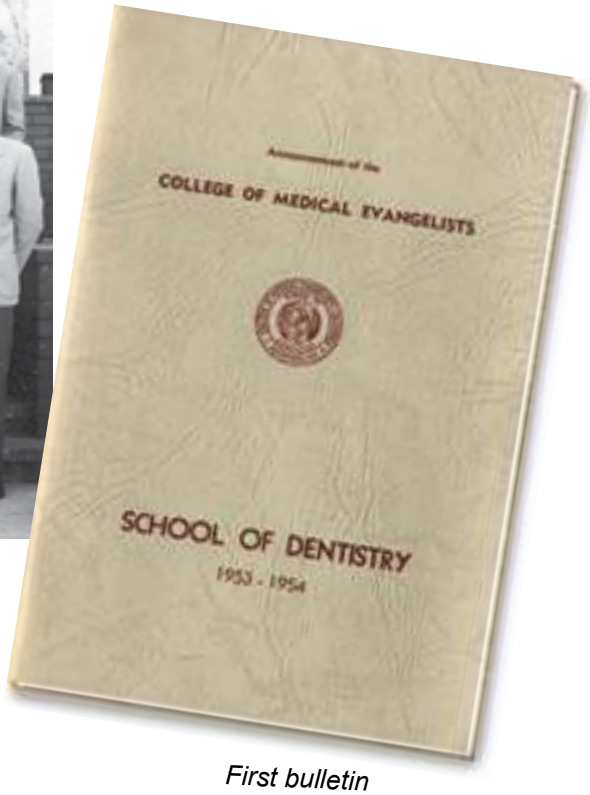
LLUSD became the fourth dental school in the State of California, opening more than 50 years after the other three (UCSF, UOP, and USC).* The new students had to attend dental technique courses in temporary facilities on campus until September 18, 1955, when they moved into the brand-new dental building. It was later named Prince Hall. Despite the many challenges in being the first students in a new school, 39 of the 42 students completed the four years of study and passed licensure exams across the United States.

The principal purpose for establishing a dental school in Loma Linda was to provide Adventist young people an opportunity to obtain dental education without the Saturday attendance required at most of the other dental schools. For many years, the National Association of Seventh-Day Adventist Dentists (NASDAD) urged CME to start a dental school. Inviting Dr. Prince to be the founding dean was a significant component of establishing the new school.

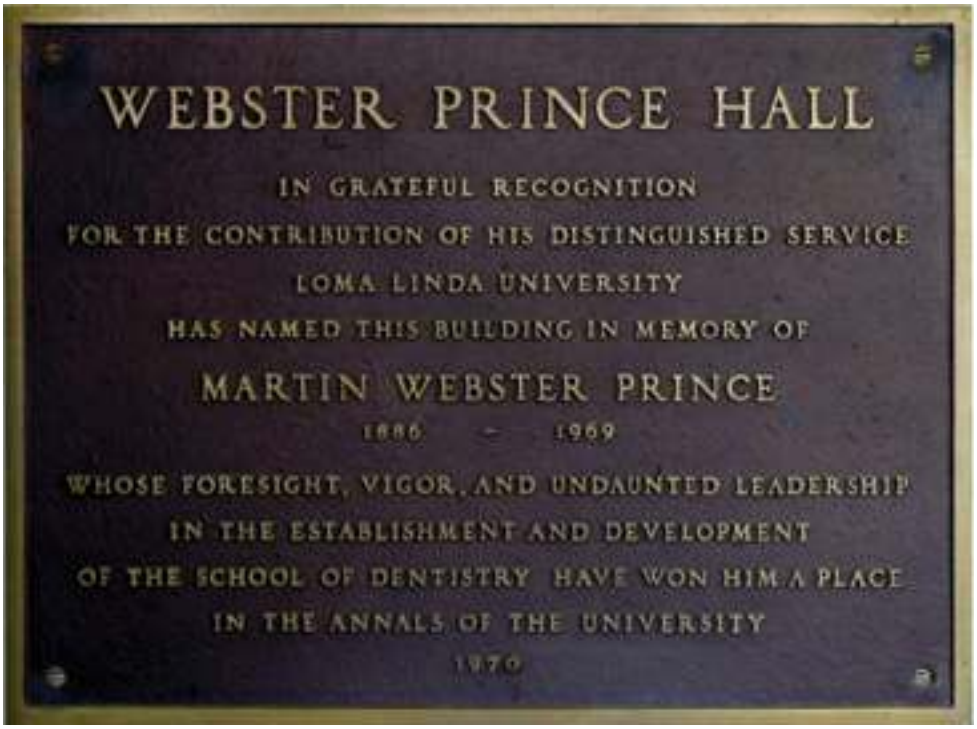
Dr. M. Webster Prince

Prince Hall upon completion
September 18, 1955

First dental class and faculty
1953-1957



First bulletin
1953



Commemoration of the finished Prince Hall

Dr. Prince had a strong background in the dental profession, both as a practitioner and a leader in organized dentistry nationally. His goal for the new school in Loma Linda was to make it an outstanding educational institution that included a commitment to dental research. For that purpose, he made sure to dedicate research space in the new building.

Considering the enormous effort to develop and begin a new dental school, including building physical facilities and recruiting qualified faculty and staff, one would not expect 'the new kid on the block' to gain much recognition early on. However, the pioneering faculty was up to the task and strongly encouraged by Dr. Prince.

When recruiting faculty members for the new school, Dr. Prince looked for dentists who shared his enthusiasm for improving all aspects of the dental profession. Whereas some of the pioneering faculty had already obtained advanced education, he encouraged the new recruits to gain additional education in various disciplines of dentistry. As a result of Dr. Prince's leadership, the School of Dentistry took part in advancing the dental profession from the very beginning of its existence. That dedication to contribute to dental science and practice has continued over the seven decades of the School's existence.

This review aims to highlight specific areas of dentistry where LLUSD faculty members have contributed to the profession by developing and introducing improved or new dental materials, instruments, and treatment procedures.

**UCSF – University of California San Francisco; UOP – University of the Pacific; USC – University of Southern California.*

Reducing Pain and Anxiety

How fortunate for the new dental school in Loma Linda that several of the original faculty members were either established leaders in the profession or had the capability to become leaders.

Dr. Niels Björn Jörgensen

One such established professional was Dr. Niels Björn Jörgensen. A 1923 graduate of UCSF, Dr. Jörgensen devoted his professional life to finding ways to reduce the pain and anxiety associated with dental treatment. Having experienced dental pain growing up and, at the age of twelve, the extraction of two molars without any local anesthetic, he was fully aware of what dental patients were experiencing. He established his dental practice in Los Angeles in 1926 with the goal of providing comfortable treatment for his patients. To that end, he combined general dental practice with clinical research in local anesthetic techniques and intravenous (IV) sedation with the use of barbiturates.

Dr. Jörgensen's research interest led him to enroll in a head and neck surgical anatomy course at the White Memorial Hospital of the College of Medical Evangelists (later LLU) School of Medicine. He was allowed access to 1,400 skulls that he meticulously measured to locate the best sites for more precisely injecting local anesthetic solutions. His findings were published in the Journal of Oral Surgery and provided the basis for Dr. Jörgensen's innovative improvements in local anesthetic techniques.

His dedication to clinical research resulted in the appointment as associate professor in the School of Medicine in 1942. He also volunteered one day a week in the White Memorial Oral Surgery Clinic. Because of his connection with White Memorial and the reputation he had developed both as a researcher and clinician, when Dr. Webster Prince was recruiting faculty for the new dental school in Loma Linda, he invited Dr. Jörgensen to teach dental anesthesia. The dental students at Loma Linda, beginning with the first class, were thus able to learn more precise local anesthetic techniques than were commonly used in dentistry at that time.

The local anesthetic techniques commonly taught could best be described as insufficient, suggesting to "insert the syringe needle quickly, aim for the likely location of the nerve, and inject the anesthetic solution." As was well-known by patients, it was not a pleasant procedure, and many chose to have dental procedures done without local anesthesia. The Jörgensen approach to improve the anesthetic success with minimal or no discomfort, was to inject slowly, follow anatomical landmarks, and use minimal amounts of anesthetic solutions. To demonstrate how to inject local anesthetics, Dr. Jörgensen produced several teaching films that were recognized worldwide for their excellence.

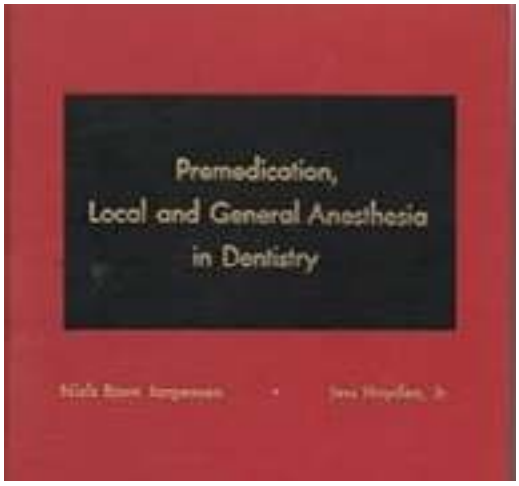
What may be considered the first major contribution of LLUSD to the practice of dentistry is undoubtedly the vastly improved local anesthetic techniques developed by Dr. Niels Björn Jörgensen. When Dr. Jess Hayden, Jr. joined the faculty in the late 1950s, the two of them collaborated on many articles and publications. Among their many publications about dental anesthesia techniques, they also published in 1965 a chapter in Dental Clinics of North America on the complications of local anesthesia.

From the beginning of his dental practice, Dr. Jörgensen had a major goal: To make it more comfortable for patients with anxiety about dental treatment to receive treatment. In addition to developing and teaching effective and painless local anesthetic techniques, he also wanted to help patients tolerate lengthy, traumatic dental procedures as well as treatment when local anesthesia was ineffective for various reasons. That led him to develop a conscious sedation procedure that became an additional contribution to the practice of dentistry from LLUSD.

Dr. Jess Hayden, Jr.

In his early years of practice in Los Angeles, Dr. Jörgensen administered oral doses of pentobarbital (Nembutal) but realized that oral administration was not adequately precise. After joining the College of Medical Evangelists at White Memorial Hospital in Los Angeles in 1942, he collaborated with Dr. Forrest E. Leffingwell, chair of the Department of Anesthesiology, to develop an intravenous technique for the administration of Nembutal to achieve a desired level of conscious sedation. Following the barbiturate injection, small amounts of meperidine (Demerol) and scopolamine were injected.

The conscious sedation technique developed by Dr. Jörgensen, which he called the "Loma Linda Technique," received worldwide recognition and became part of the dental curriculum at LLUSD from the beginning of the School's history. Despite his modesty, the technique was more often referred to as the "Jörgensen Technique." A major advantage of the technique is that it maintains the patient's protective cough reflex and allows cooperation with the dentist. The local anesthetic techniques and the conscious sedation procedure were included in a major 1966 textbook, Sedation, Local and General Anesthesia in Dentistry, by Dr. Jörgensen and his colleague, Dr. Jess Hayden, Jr.



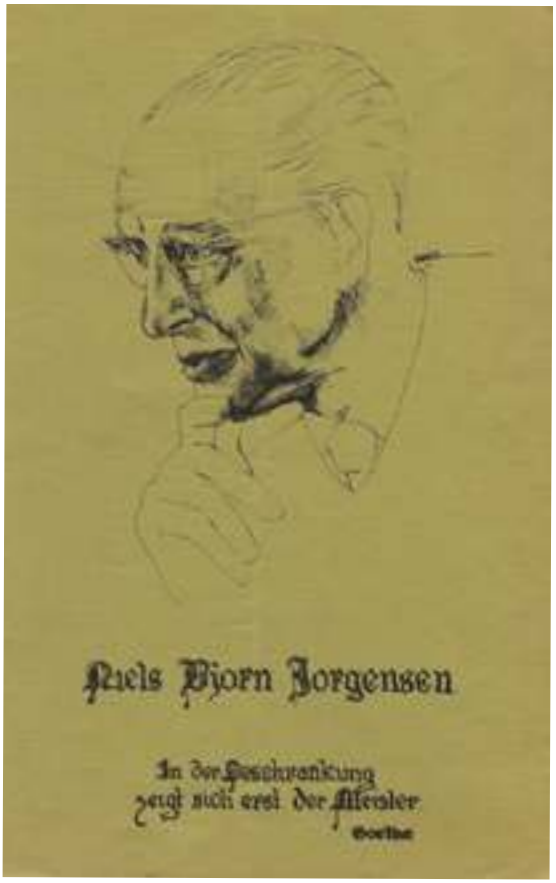
Textbook by Dr. Jörgensen & Dr. Hayden, Jr.

The University Board recognized him for his importance to the University with a special award for which he, in his usual humble manner, accepted by stating that he had received many plaques all over the world, but none was so precious to him as the LLU award. In his words: “Loma Linda has from the beginning been of great importance to my life, in spite of my accent, not being a born American and being raised in a different church, I have met so much cooperation and kindness from everybody here.” Late in life, Dr. Jörgensen joined the Adventist church.

Inspired by Dr. Jörgensen’s contribution to making dental treatment possible for patients with dental phobias and those with developmental disabilities, the Schools of Dentistry and Medicine in 1976 joined in developing an advanced education program to train dentists in providing general anesthesia for dental patients. It was approved in 1977.

Dr. Holli Riter

To prepare faculty for the program, two graduates of the School of Dentistry including Dr. David Anderson, DDS’70 - completed a 24-month residency program in medical anesthesiology at the LLU Medical Center. Subsequently, Dr. Larry Trapp was recruited to the dental anesthesia faculty.



Program honoring Dr. Jörgensen

The anesthesia program began as the Surgery Center for Dentistry in the LLU Medical Center. In 2000, the clinic was moved to the first-floor location on the northeast corner of Prince Hall. The 2500-square-foot facility includes four operating rooms. Seven years later (2007), out of appreciation for a very generous gift from Dr. Albert Koppel, DDS & his wife Dr. Betty Koppel, MD, LLUSD dedicated the facility as the Koppel Special Care Dentistry Center (KSCDC).

By 2019, the dental anesthesia program at LLUSD had trained 132 dentists to provide sedation and general anesthesia to patients needing such care. Almost half of those dentists were graduates of LLUSD. The program, and similar programs across the U.S., found it necessary to discontinue in 2019. Patients needing general anesthesia for dental care are still being provided with such care at the KSCDC. It is now a Joint Commission-accredited and CMS-certified outpatient ambulatory surgery center directed by Dr. Holli Riter, DDS’98. Dr. Riter estimates that about 3,600 patients receive treatment yearly at the Center.

Concern for dental patients’ comfort was Dr. Jörgensen’s motive for spending his professional life developing techniques and procedures that greatly impacted dentistry. It was of benefit not only

to students at Loma Linda but also contributed in a major way to making dental treatment more comfortable for patients worldwide. In 1969, the LLUSD Alumni Association and NASDAD paid tribute to Dr. Niels Björn Jörgensen for his accomplishments at a dental meeting in Chicago, with Dr. S.L. Drummond-Jackson as the speaker and Dr. Jess Hayden, Jr. as master of ceremonies.

What is Dental Caries?

Dr. Ralph Steinman

Another established dental educator invited by Dr. Prince to join the new school in Loma Linda was Dr. Ralph R. Steinman, who came with teaching and research experience from the University of Michigan. Dr. Steinman's research interest was dental caries, thus complementing the research by his fellow faculty members, whose work dealt with patient comfort, materials, and instruments.

While at the University of Michigan, Dr. Steinman became acquainted with the crucial microscopic research done by a former faculty member, Dr. W.D. Miller, who had identified and described bacteria associated with dental caries. In Dr. Steinman's view, however, bacteria could not be viewed as the sole cause of dental caries. Thus, he began, with the approval of Dr. Prince, to explore other factors associated with this dental disease.

In the beginning of his research, Dr. Steinman focused on the anatomy of dentin, specifically the dentinal tubules and the fluid within the tubules. He wanted to know if dentinal fluid flow played a role in caries. He began to explore the role of dentinal fluid movement and the possibility that hormones and other agents could be transported through the tubules. It is interesting that, more recently, pulpal pain can in some cases be associated with dentinal fluid flow.

Evidence Suggesting the Existence of a Hypothalamic-Parotid Gland Endocrine Axis

JOHN LEONORA AND RALPH R. STEINMAN

Department of Physiology and Biophysics, School of Medicine and Department of Oral Medicine, School of Dentistry, Loma Linda University, Loma Linda, California 92354

ABSTRACT. Evidence for the existence of a hypothalamic-parotid endocrine axis was demonstrated with a fluorescent dye technique. The intraperitoneal injection of the dye, acriflavine hydrochloride, provided a simple method to study the movement of fluid through the odontoblastic tubules in the dentine of rat molars. Hypothalamic extract (HE) injected iv into intact rats stimulated the movement of fluid through the odontoblastic tubules in the dentine. Extracts of other tissues and antidiuretic hormone failed to duplicate the effect observed with HE. Fluid movement was not obtained in sialoadenectomized rats. Fluid movement was obtained only when the HE was administered to rats with intact parotid glands or when parotid tissue extract was given iv to parotidectomized rats. These results suggest that the hormonal stimulation of fluid movement through the odontoblastic tubules is directly dependent upon the parotid. Fluid movement was obtained in hypophysectomized rats, which indicated that the hypothalamic factor acted directly on the parotid gland rather than through the anterior pituitary gland. Evidence was obtained that the hypothalamic factor is not the recently isolated sialogen. (*Endocrinology* **83:** 807, 1968)

After several years of dental caries research, Dr. Steinman teamed up with Dr. John Leonora, a basic science faculty member at the LLU School of Medicine, to explore a possible hormonal, systemic role in dental caries. Their observation: excess dietary sugar has a detrimental effect on the natural outward flow of nutritive and cleansing dentinal fluid and could have significant public health considerations.

In his professional career at Loma Linda University, Dr. Steinman and his research collaborators made numerous contributions to the understanding of dental caries. Some of the findings showed that metabolic factors were involved in incipient dental caries. In addition, they noted that many other factors were involved, such as psychological stress, electrolytes, change of local metabolism, frequency of unenriched diets, dietary sugar, the immune system, and many additional systemic components. Their research resulted in nearly 100 publications.

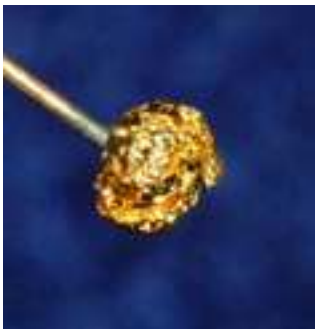
Caries research does not catch the same attention and interest that dental materials and clinical procedures do. Understanding the disease, however, can lead to its prevention and management of the disease process. It is fortunate that Dr. Steinman and his colleagues recognized the importance of caries research, and their contribution to dental science is part of the Loma Linda legacy.

Restoring Teeth - Innovative Methods & Materials

Dr. Lloyd Baum, a graduate of the University of Oregon, was invited by Dr. Prince to join the new dental faculty at Loma Linda. Dr. Baum had a keen interest in metallurgy, both in terms of dental restorative materials and dental instruments. Dean Prince encouraged Dr. Baum's interests and included a research facility for dental materials in the new dental building.

Dr. Lloyd Baum

One of Dr. Baum's many interests in restorative dentistry was gold foil as a filling material. He had completed more than 50 such restorations while in dental school and many additional ones after graduation. One problem with gold foil as a restorative material is that it is time-consuming to fill a dental cavity with foil material. Fortunately, a dental student (Earl Collard, SD'62) brought a small container of gold powder from a dental meeting in Chicago. Dr. Baum envisioned "packing" the powder in pieces of foil that could be condensed into dental cavity preparations, allowing more rapid filling of the cavity. His colleague, Dr. Melvin R. Lund, joined Dr. Baum in developing the powdered gold into a practical material for use in dentistry. As a commercial product, *Goldent*, as it was first called, helped make Loma Linda a name in restorative dentistry worldwide. Graduates used the powdered gold to impress state board examiners across the country. Dental students during the 1960s remember that in addition to developing *Goldent*, Dr. Baum also developed white head caps for more comfortably supporting dental dams required for procedures such as gold foil and endodontics.



Goldent Pellet

Dr. Lund & Dr. Baum with dental dam head caps

Collaborating with colleagues at Loma Linda University School of Dentistry and elsewhere was one of Dr. Baum's strong characteristics. With Dr. George Hollenback, a premier dental scientist from USC, he developed what became known as the Baum carvers. He also paid close attention to dental developments elsewhere and noted that a colleague, Dr. E. David Shooshan, suggested drilling pin holes in denture teeth for attachment to bridge abutments. Dr. Baum developed a technique and an instrument, the Loma Linda Parallelometer, with which one could accurately drill pin holes in teeth to support gold castings. With the support of the pins, less tooth structure needed to be removed to retain a gold restoration. Pin-retained restorations became quite common.

Pin-retained restoration

While gold foil and pin-retained gold castings are no longer commonly used in dentistry, they played an essential role in the continuing evolution of restorative techniques and materials. Dr. Lloyd Baum, and the colleagues who had the opportunity to collaborate with him, contributed significantly to the improvement of dental procedures and materials.

It would be neglectful to focus only on Dr. Baum's innovations in dental materials and techniques. He had many talents and focused his efforts on improving our profession in numerous ways.

He was a founding faculty member of three schools: LLUSD (1953), Stony Brook University School of Dental Medicine in New York (1973), and Montemorelos in Mexico (2005). The latter school is named after him: the Lloyd Baum School of Dentistry. After a hiatus at Stony Brook, NY, Dr. Baum returned to Loma Linda and organized the International Dentist Program at LLUSD in 1985. Always keen on mission service, in 1991, he designed the most modern dental clinic at the time in China at Sir Run Run Shaw Hospital in Hangzhou. Dr. Lloyd Baum, with his many talents, contributed those talents to LLUSD as well as the dental profession worldwide.

Replacing Missing Teeth - Dental Implants

Dr. Robert James

Replacing missing teeth with implants to support dental prostheses has a long history going back to ancient times. The modern era began in the 1960s, and the endosteal blade implant was a popular version at the time. Dr. Lloyd Baum was an LLUSD faculty member who recognized the potential for this new treatment approach. After attending a presentation by Dr. Robert A. James at the 1969 NASDAD meeting in Grossinger, NY, he recommended that Dr. James be invited to join the faculty at LLUSD. Dr. James accepted the invitation and moved to Loma Linda the following year, 1970.

Dr. James, born and raised in California, had moved to Bermuda after completing dental school at USC in 1960. Bermuda dentists would usually fly to New York for continuing dental education, where Dr. James began to attend lectures on dental implants. He became acquainted with dentists like Dr. Norman Cranin and Dr. Leonard Linkow, who were active in that field of dentistry. Dr. James brought that experience with him to LLUSD.

Dr. James recognized the importance of incorporating a scientific approach to the development of clinical procedures in dentistry. He enrolled in a master's degree program at LLU. His research showed the presence of hemidesmosomes and the adhesion of epithelial cells to metal implants, an important step in implant research. He continued his research and, for a while, housed the monkeys used for research in his own garage!

In addition to research and development, in 1976 Dr. James started the first university-based advanced education program in implant dentistry in the U.S. It became the largest postgraduate training program in the world, and numerous innovations have originated at LLUSD. An important early development was a research project in 1980 by graduate student Dr. Phil Truitt, in which the newly developed computer tomography (CT) technology could be used to produce more accurate casts of alveolar ridges for fitting subperiosteal implant frameworks.

Dr. Jaime Lozada

In 1984, Dr. Jaime Lozada became the fifth graduate student in the implant dentistry program. He developed a close working relationship with Dr. James and assisted him on numerous projects, including the research on monkeys in Dr. James' garage. Over time, Dr. Lozada also took on more roles in the program, and at Dr. James' untimely death in 1993, Dr. Lozada was appointed program director. In 2003, Dr. Lozada invited the developer of the modern Brånemark implant system to visit LLUSD.

In 2017, the International Journal of Oral and Maxillofacial Implants listed the 100 top cited articles in implant dentistry. In two of these articles, Dr. Charles Goodacre, a prosthodontist and dean of LLUSD at the time, was the first author. The three top institutions producing the highest numbers on the list were the University of Gothenburg, Sweden, the University of Bern, Switzerland, and Loma Linda University. The Loma Linda articles, listed as “classic” by the journal, were co-authored by Drs. Joseph Kan, Kitichai Rungcharassaeng, Charles Goodacre, and Jaime Lozada.

With its many accomplishments, the implant dentistry program at LLUSD has contributed to the dental profession both in terms of the science and practice, but also in helping to train dentists to provide treatment for patients that could benefit from this type of dental treatment.

Dr. Jaime Lozada, Dr. Per-Ingvar Brånemark, & Dr. Charles Goodacre

Periodontics- The Loma Linda Group

Research activities at LLUSD increased when Dr. Richard C. Oliver in 1962 earned a Master's Degree in periodontal disease from LLU. He subsequently earned a Fullbright Scholarship to study periodontal research in Scandinavia. When he returned, he began working on establishing an advanced education program in periodontics, which opened for enrollment in 1965.

Dr. Richard C. Oliver

During his Fullbright period in Scandinavia, Dr. Oliver became acquainted with a young researcher in periodontics in Sweden, Dr. Jan H. Egelberg. That connection led to Dr. Egelberg being invited to Loma Linda in 1975, where for the next quarter century extensive clinical research and treatment development in periodontics took place.

Dr. Egelberg became a driving force in research on general wound healing processes and the specific factors that regulate cell functions in periodontal tissues. That research made it possible to develop strategies to enhance periodontal healing through root surface conditioning and guided tissue regeneration. A major presentation was made in 1980 at the annual session of the American Academy of Periodontology. After that, "The Loma Linda Group" became well-known in periodontal academic circles worldwide.

Dr. Jan H Egelberg

Over time, other leading periodontal researchers from several Scandinavian countries joined the program at LLUSD. An excellent review of the Loma Linda Group contribution to the field of periodontics can be found in LLU DENTISTRY, 2007, Winter/Spring issue (Selvig, Knut A. Periodontal regeneration-the Loma Linda contribution. LLU Dentistry, 2007;18(1. Winter/Spring):11-14). The author, Dr. Selvig, came from Norway in 1976 to collaborate on research with Dr. Egelberg for one year. Over the next three decades Dr. Selvig returned as a visiting professor several times to both guide research projects and direct the advanced education program in periodontics.

The Loma Linda Group gained additional recognition for work on osteogenesis and new cementum formation through the application of enamel matrix extract. Research projects evaluating the characteristics of treated root surfaces following periodontal regenerative therapy using scanning electron microscopy were extensively reported.

Orthodontics - Innovative Use of Computer Tomography

The first graduate program at LLUSD was in orthodontics, beginning in 1960. From early on, innovative procedures were developed and incorporated into the teaching experience for the students. They included the Quint Sectograph and the Quick CephTM. The opening of the Ricketts Library in 1997 nurtured the interest in looking for and incorporating advanced techniques in the teaching of orthodontics.

One such advanced technique was the development of a volumetric x-ray machine by NewTomTM9000, manufactured by QR srl, Verona, Italy. It was specifically designed to image head and neck skeletal and dental issues. The orthodontic program director, Dr. Joseph Caruso, discovered this innovation in an engineering journal in 1998. He contacted a colleague in Italy to get more information and learn how to obtain such equipment. Two Italian colleagues who were co-developers of the Bio ProgressiveTM Orthodontic Treatment Philosophy would facilitate exporting such a unit to LLUSD. The company successfully pursued the process of getting FDA approval for use in the United States.

The diagnostic unit, NewTom 9000, was specifically a cone-beam computed tomography (CBCT) unit that could be used for volumetric imaging for orthodontic treatment and research. The first unit exported to the United States came to LLUSD's orthodontic program in 2001. The co-developer of the equipment came to Loma Linda to help install it. Using the NewTom required extensive preparation to obtain approval from the State of California for dentists to operate and supervise dental assistants with radiographic licenses.

Having the first CBCT unit at LLUSD, Dr. Caruso, and later Dr. Kitichai Rungcharassaeng, provided training in the use of this innovative technology to other faculty members and students at LLUSD as well as to other programs in the United States and Canada. The program also provided an opportunity for CBCT imaging of other patients in San Bernardino County. In addition, the new imaging facility provided opportunities for more precise measurements and placement mapping for patients receiving dental implants. Over the next several years, LLUSD orthodontic faculty members were invited to train colleagues and students in other dental schools to use and understand CBCT.

Installation of NewTom 9000, 2001
From left to right Dr. Charles Goodacre, Dr. Joseph Caruso, Dr. Lynn Behrens, Dr. Richard Hart

Incorporating advanced technology and information into educational programs at LLUSD has been a characteristic of the educational environment since the beginning of the School. The innovative developments in the orthodontic program have represented forward thinking at the School since its start.

Bioceramic Cements - A Major Endodontic Innovation

Dr. John Ingel & Dr. Mahmoud Torabinejad

Dr. Mahmoud Torabinejad joined the Department of Endodontics faculty in Loma Linda in 1977. He completed the advanced education program in endodontics at the University of Washington in 1976, followed by a year of dental research at the Forsyth Dental Center in Boston. His educational background and interest in dental research led him to take on the supervision of research projects with graduate students in endodontics. He also conducted numerous research projects with Loma Linda faculty and colleagues from around the world; that research effort has led to more than 300 publications and eight books.

One of his many areas of interest in endodontics was management of root perforations. Repairing perforations was complicated by the fact that existing dental materials required a dry environment, which is difficult to obtain in such situations. Fortuitously, Dr. Torabinejad observed that when Portland cement is used for construction, the material requires moisture for its setting process. Could such cement be used in dentistry?

Old European dental literature reported on the use of Portland cement as a filling material, but it did not catch on. Dr. Torabinejad recognized the potential for a material requiring moisture to cure, which would be in situations such as root perforations and root end fillings during apical surgery. These are locations where moisture often is a problem. He proceeded to work on developing a material suitable for moist environments. The project became the subject of his PhD thesis, which he completed at the University of London under the supervision of Dr. Thomas Pitt Ford.

Dr. Torabinejad modified several types of Portland cement and came up with one that had good sealing ability and was biocompatible and safe for use in humans. It was also sufficiently radiopaque to be recognized on dental radiographs. The results led to the development of a new dental material that he named MTA (mineral trioxide aggregate). Loma Linda University patented the invention, and it was marketed as ProRoot MTA in 1998 by Dentsply International after several years of bench top tests and clinical research. The income from the patent benefitted both the School of Dentistry and the University.

The application of the new dental material, MTA, exceeded initial expectations. In addition to its indication for root perforations and root-end fillings, it soon found application as a superb material for apexification, pulp capping, pulpotomy, pulp regeneration, root canal obturation, root canal sealer, and repair of resorption defects. Continued research by Dr. Torabinejad and others worldwide demonstrated other benefits, such as stimulation of hard tissue formation, an example of which is cementum forming against MTA when used as a root end filling.

MTA was the first of what now is referred to as bioceramic-based cements and is recognized as a gold standard for materials used in the situations described. It is one of the truly beneficial advancements in dentistry. It is impossible to estimate how many teeth have been retained because of the availability of this innovative dental material. The dental literature, however, contains more than 3000 case reports and case studies as well as systematic reviews describing its biologic value in dentistry. It is truly a significant contribution to dental practice and science.

Advances in Oral & Maxillofacial Surgery

Dr. Phillip Boyne

In 1978, Dr. Philip Boyne was appointed director of the advanced education program in oral and maxillofacial surgery, in which implant surgery is also a component. His pioneering work included bone grafts combined with bone graft substitutes, enabling surgeons to restore traumatized jaws. In 1990, he enhanced implant dentistry and other hard tissue research by establishing the Bone Research Laboratory. Some of the highly specialized equipment in the laboratory allows researchers to cut ultra-thin bone specimens containing metal implants. The procedure enhanced the ability to study critical interfaces between bone and metal.

Dr. Boyne's work on bone grafting led to collaboration with Geistlich Pharma AG in Switzerland, a company that has excelled in producing materials for grafting. Dr. Boyne helped recruit the current department chair, Dr. Alan Herford, and the two of them worked extensively with the company on grafting materials. That resulted in the company's president, Peter Geistlich, establishing through a generous donation, the Philip J Boyne & Peter Geistlich Professorship, which in 2008 was awarded to Dr. Alan Herford, DDS'94, MD.

Continuing in the tradition of Dr. Boyne, research in grafting materials for bone has continued in the department to benefit the many patients in need of such procedures.

Dr. Alan Herford

The Role of Pediatric Dentistry in Orofacial Clefts

Cleft lip and cleft palate are among the most common craniofacial abnormalities in the United States. They occur in one of every 700 to 1,000 newborns. The causes can be multifactorial and include genetics, drugs, vitamin deficiency or excess, and cigarette smoking. Environmental and other unknown factors may also contribute. The traditional treatment has been surgical correction, which often requires several procedures and tends to leave some disfigurement.

More than 30 years ago, an innovative procedure for presurgical treatment was developed that allows surgeons to make the repair with one surgical procedure. The procedure uses an appliance called nasal alveolar molding (NAM) that not only molds the affected intraoral and extraoral structures, but also provides nasal support to mold collapsed nostrils. It improves the position and symmetry of nasal deformities and has shown a significant reduction in the size of the cleft intraorally. Surgery after NAM is less invasive and often results in more esthetic outcomes.

Dr. Jung-Wei Chen

The use of NAM is technically challenging, and LLUSD was fortunate that when Dr. Jung-Wei Chen joined the School to become director of the Graduate Program in Pediatric Dentistry in 2008, she brought with her the training and experience to provide such treatment. Dr. Chen's leadership in providing this vital care for babies born with orofacial clefts has made LLUSD a leader in this field, improving the lives of numerous babies with such craniofacial abnormalities.

While the procedure using NAM has been very successful, access to this care has not always been readily available. Dr. Chen has been persistent in working with state and medical insurance agencies to cover the cost of the appliance and procedure. She has also developed improvements in the design of the NAM appliance with more flexible nasal stents and stability buttons to make the appliance more stable. This modified appliance is referred to as a PNAM (Presurgical Nasal Alveolar Molding) appliance. The orthodontic-retainer-like device enhances the effectiveness of surgery and reduces the number of surgeries required to achieve a functionally and cosmetically satisfying correction. Further enhancements include the use of updated digital scanners and 3D printers.

The following LLU website provides more information about the treatment described: What you can do to help Cleft Lip and Cleft Palate.

Progress in LLUSD Dental Research

The founding dean of LLUSD, Dr. M. Webster Prince, envisioned a dental school that was not only an educational facility where Adventist students could keep the Sabbath in a customary way but also a high-quality institution that included dental research.

Under the leadership of Dr. Prince, dental research became an important educational activity at the School. Many faculty members engaged actively in research. Dental and dental hygiene students were encouraged to get involved in research projects. This resulted in research presentations at both state and national dental meetings. The quality of their research led to many presentation student awards.

Dr. Anthony Tjan

Research at LLUSD gradually moved from individual faculty activities to a School-wide activity led by researchers like Dr. Anthony Tjan, who joined the faculty in 1984. Dr. Tjan had extensive research experience in dental materials and guided faculty members and students in such research, resulting in worldwide presentations.

Further enhancement in dental school research happened when Dr. Charles Goodacre became Dean in 1994. He shared the vision of the founding Dean of the importance of dental research. He took steps to further strengthen the School's research program in materials sciences by recruiting colleagues from Indiana University. Among them were a husband-and-wife research team from Indiana University, Drs. Yiming Li and Wu Zhang.

Under Dr. Li's leadership, the Center for Dental Research (CDR) became known for its clinical research, biocompatibility of dental materials, and tooth whitening. A major development took place in 2015 when the CDR moved to a new 5,600-square-foot research facility in the Chan Shun Pavilion on the University's main campus. The facility includes a clinic with five dental operatories and several laboratories.

Dr. Wu Zhang & Dr. Yiming Li

Currently, the CDR has several state-of-the-art pieces of equipment, such as microtomography (micro-CT), scanning electron microscopy (SEM), Instron test machine, automatic platter and colony counter, and polymerase chain reaction (PCR) analyzer. So far, the CDR team has conducted more than 110 clinical studies and approximately 700 laboratory projects funded by government, foundations, and industrial sponsors. That has been in addition to mentoring graduate students, dental and dental hygiene students, and clinical faculty in their research projects. The Center has also provided improved facilities for dental and graduate students to work on research projects.

A major development by the CDR was the establishment in 1998 of a Sterilization Assurance Service (SAS) for testing sterilization equipment. Dr. Wu Zhang developed the program and stayed as the director of the service until her retirement in 2021. The SAS was established initially to serve LLUSD alumni; it has since grown to provide services to other dental professionals nationwide. In 2000, the SAS added the Dental Unit Waterline (DUWL) Testing Service, which dental offices are now using in 34 states.

Dr. Yiming Li stepped down as director of the CDR in 2019, turning the directorship over to Dr. Montry Suprono, DDS, MSD, who earned both his dental (2007) and advanced degree (2011) at LLUSD. The research activities that have been accomplished since the beginning of the School in 1953 no doubt would meet the expectations of its founding Dean Dr. M. Webster Prince.

Conclusion

The founding dean of LLUSD, Dr. M. Webster Prince, envisioned a dental school that was not only an educational facility where Adventist students could keep the Sabbath in a customary way, but that it was also to be a high-quality institution. In his view, that included dental research. He encouraged the founding faculty to engage in research and included space for research in the original dental school building.

From its beginning, Loma Linda University became a school where faculty members felt inspired to improve the profession by developing procedures and materials that would benefit the patients. To that end, the contributions described reflect the school's educational philosophy from its beginning.

Prince Hall over the years

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