An ethical perspective to using bone grafts in dentistry

Sukhjit Gill, DDS; Meghna Prakash, BDS; Mohsen Forghany, DDS; Ram M. Vaderhobli, DDS, MS

The American Dental Association Principles of Ethics and Code of Professional Conduct establishes the ethical expectations from dental providers that obligate a moral commitment toward the welfare of their patients and oral health care team.1 One such expectation that requires careful navigation is patient autonomy—patients’ ability to be involved in and self-determine their treatment on the basis of their views, beliefs, desires, and choices independent of the treating dentist’s will.1 Patient autonomy is a pressing concern when a recommended treatment conflicts with a patient’s spiritual or religious beliefs. One of the fastest growing and ethically undervalued treatments is bone grafting in preparation for the placement of endosseous dental implants or other restorative dental therapy.7

Bone grafts are natural or synthetic bone substitutes that are used to create a scaffold for bone formation and to facilitate optimum wound healing.2 In dentistry, bone grafts are used commonly in conjunction with dental implants to enhance the regenerative capacity of bone after tooth loss, along with other periodontal procedures. On the basis of the origin of the donor tissue, bone grafts can be classified into 6 categories: autografts or autogenous grafts, allografts, xenografts, alloplasts or alloplastic materials, composite grafts, and synthetic regenerative bone grafts.3-5 An overview of the types of bone grafts and their sources and biological mechanisms are provided in the table.4-8

MARKET VALUE OF BONE GRAFT MATERIAL
In 2020, the global dental bone graft and substitutes market size was valued at $663.2 million and is estimated to grow at a compounding annual rate of 11.4% from 2021 through 2028.9 Increasing use of bone grafts in dental implant surgeries and associated high success rates are propelling the market growth, and, with the rise in the global geriatric population, an increased prevalence of periodontal diseases and edentulism is expected.10 Consequently, a higher demand for bone substitute materials is anticipated.9

PATIENT ACCEPTANCE OF DIFFERENT BONE GRAFTS
As a general trend, autologous grafts and alloplasts have the highest rates of acceptance among patients, and most people prefer to harvest bone from the posterior mandible or retro-molar region than from any other intraoral or extraoral site for autologous grafts.10-13 According to a survey of a French patient population, bone grafting products derived through regenerative medicine were accepted to a similar degree as autografts.5 Conversely, the highest rates of refusal were seen with allografts and xenografts.10-13 Common grounds for refusal included fear of disease transmission, religious beliefs, and moral conflict.13 However, despite the high refusal rates reported in the literature, xenografts had the largest revenue share among bone grafts, accounting for more than 47% of sales in 2020.9 Some hypotheses to explain this discrepancy could include misconceptions regarding the patient and the dentist regarding the composition of xenografts or even a dentist’s lack of knowledge about bone grafts. Lastly, regarding composite graft acceptance, there is a lack of specific literature regarding this treatment. Nevertheless, it may be worth considering that the blended nature of composite grafts possibly can lead to refusal from patients who may have an objection toward any of the component materials.

RELIGIOUS AND SPIRITUAL CONSIDERATIONS
An ethical perspective should be considered carefully when recommending the use of various bone grafts because patients’ unique cultural, spiritual, or religious beliefs will influence their treatment preferences. Furthermore, patients’ religious beliefs historically have been undervalued in human studies evaluating bone graft effectiveness to repair osseous defects.14 The views, beliefs, and customs adopted by various religious and cultural groups may differ from one another, yet one of the major conflicts reported is the use of animal-derived products or tissues from another human for medical or surgical treatment.15,16

Depending on the religious context, some groups view animals as sacred, thereby making it wrong to kill or consume them, whereas others consider certain animals unclean or impure. Certain religions such as Judaism and Islam, as well as Hinduism, forbid the consumption of porcine-derived products such as pork.17,18 According to a study conducted by Güngörmiş and Güngörmiş,19 religious affiliation predominantly impacts porcine-derived tissues. Furthermore, Hinduism and Sikhism deem it sinful to kill animals for human gain and do not approve the use of bovine or porcine materials for surgical treatment. When it comes to human-derived products or tissues such as allografts, Christianity, Hinduism, and Sikhism permit their use if prior consent was obtained from the tissue recipient.15 However, a large population of Hindus believe in cremation as a whole with no mutilations, and, therefore, the use of cadaver parts may be contraindicated.16 Conversely, Buddhism and Islam do not have any restrictions regarding the use of allogenic or xenogeneic
materials. Although Jehovah’s Witnesses strictly forbid the use of human blood—derived products, such as in transfusions, they usually do not object to the use of human-derived tissues for treatment purposes. Religious leaders and regional dental licensing boards generally advocate the practice of obtaining the tissue donor’s informed consent when considering the use of human-derived tissue. A caveat when evaluating evidence is overgeneralization because patient preferences may vary among geographic locations depending on the religious and cultural diversity of the population. Furthermore, the views of religious leaders are not universal because people of the same religion may display a spectrum of opinions regarding the use of animal and human tissues in dental treatment.

Nowadays, philosophies such as ethical veganism are on the rise, and their followers do not accept the use of animal-derived products in the presence of other alternatives. A study by Bucchi and colleagues reported that not only do sociodemographic variables or religious affiliation influence a patient’s decision to receive a bone graft but so does the desire to avoid harming animals for human gain. According to a study investigating religious and cultural views on soft-tissue regeneration, vegans prefer to use allogeneic materials over animal-derived products, despite potential higher cost and lower efficacy. To our knowledge, there are no studies that focus on vegan perspectives on the use of bone grafts; however, greater emphasis is being placed on vegan ideals in the development of animal-free treatment options.

**ROLE OF THE DENTIST**

Dentists are expected to adhere to the principles of beneficence, nonmaleficence, justice, autonomy, and veracity to treat their patients ethically. The violation of patient autonomy in bone graft cases can have severe consequences, such as the loss of trust in the treating dentist or in the profession and potential treatment discontinuation. A case series by Sattar and colleagues describes 4 distinct cases in which the use of animal-derived inert medication ingredients such as gelatin and stearic acid conflicted with patients’ faiths and led to discontinuation of these medications and nonadherence to treatment. The American Dental Association Commission on Dental Accreditation standards require that dental educational programs develop and implement educational processes encouraging a patient-centered and comprehensive approach to oral health care delivery and “ensure that patient preferences, and their social, economic, emotional, physical and cognitive circumstances are sensitively considered.” To practice mindfully and with cultural competency, dental health care providers can discuss the source of bone grafts with patients and obtain proper informed consent for treatment. Dentists should be encouraged to hold conversations regarding religious beliefs and values when considering the use of bone grafts to

---

**Table.** An overview of the different classes of bone grafts used in dentistry.

<table>
<thead>
<tr>
<th>BONE GRAFT</th>
<th>TISSUE OF ORIGIN OR SOURCE</th>
<th>HARVEST SITE OR MATERIAL USED</th>
<th>BIOLOGICAL MECHANISM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autograft</td>
<td>Bone tissue harvested from a different site in the same patient</td>
<td>Iliac crest, mandibular symphysis, anterior mandibular ramus, maxillary tuberosity, exostoses, implant osteotomy site debris</td>
<td>Osteoconduction, osteoinduction, osteogenesis</td>
</tr>
<tr>
<td>Allograft</td>
<td>Bone tissue from another person</td>
<td>Cadaveric bone tissue: fresh, fresh frozen, freeze-dried bone allograft, DFDBA*</td>
<td>Osteoconduction, weak osteoinduction</td>
</tr>
<tr>
<td>Xenograft</td>
<td>Bone tissue from a source of a different species</td>
<td>Bovine bone, porcine bone, equine bone, natural corals</td>
<td>Osteoconduction</td>
</tr>
<tr>
<td>Alloplast</td>
<td>Synthetic substitute or deorganized biocompatible materials</td>
<td>Ceramics, calcium phosphate cement, HA, tricalcium phosphate BCS, bioactive glass, glass ionomers</td>
<td>Osteoconduction</td>
</tr>
<tr>
<td>Composite Grafts</td>
<td>Combination of ≥ 2 graft materials from various sources</td>
<td>Combination: BCS and deproteinized bovine bone, BCS and alloplast, autografts and anorganic bovine bone (Bio-Oss, OsteoGraf/N), autologous cancellous bone and nonresorbable HA (Interpore 200), autografts and DFDBA, DFDBA and bovine-derived HA (OsteoGraf/N), recombinant human bone morphogenetic proteins</td>
<td>Osteogenesis, osteoconduction, osteoinduction (≥ 1 mechanisms involved depending on combination of materials used)</td>
</tr>
<tr>
<td>Synthetic Regenerative Bone Grafts</td>
<td>Synthetic substitute using regenerative techniques</td>
<td>Human cell cultures with polymeric substitutes stimulated by growth factors</td>
<td>Osteoconduction, osteoinduction, osteogenesis</td>
</tr>
</tbody>
</table>

* DFDBA: Demineralized freeze-dried bone allograft. † HA: Hydroxyapatite. ‡ BCS: Biphasic calcium sulfate.
better understand patient priorities and avoid conflicts. The dentist must not make any assumptions of patient preferences based on the patient’s religious affiliations or cultural practices.

A study by Enoch and colleagues undertaken in the United Kingdom found that most health care professionals lack basic awareness of the components present in many biological products used in medicine. Under these circumstances, clinicians cannot provide adequate information to patients to obtain informed consent. Therefore, it is the responsibility of a competent dental practitioner to enlighten themselves, with the assistance of hospitals and manufacturers, on the components of potential bone grafts considered for intraoral use. A potential disagreement during treatment planning with a chance for resolution would be far better than the dentist facing a predicament later. Potential predicaments faced by the dentist can be in the form of patient dissatisfaction with performed treatment after the irreversible use of a material that the patient is not comfortable receiving, which may lead to loss of trust in the dentist, can damage the dentist-patient relationship and in some cases, even bear legal ramifications.

ROLE OF THE PATIENT

Practitioners should tend to rely mainly on scientific evidence, along with the aid of their experience and personal philosophies, to make clinical diagnostic and treatment decisions. In efforts to provide evidence-based care, providers inadvertently may overlook conflicting factors that are not aligned with a patient’s values. In a survey of dental patients, Chapple and colleagues conducted in the United Kingdom to understand patients’ preferred role in deciding the course of their treatment, most patients expressed their desire to be involved in a collaborative treatment decision-making process along with their dentists. The same study reported that most dental patients surveyed in both general dental practices and hospitals had perceived their roles in treatment decision making to be passive, with most of them considering that they had little to no involvement in the treatment decisions being made. Some of the patient-reported factors that disempowered them from participating actively in the decision-making process included an increased trust in the dentist, a lack of knowledge in the field, time constraints during the appointment, or even situation-related factors associated with emergency conditions or comorbidities. Patients who expressed an intent to participate in treatment decisions either assumed a consumerist stance with increased treatment awareness or distrusted their provider.

PATIENT EDUCATION AND SUGGESTING ALTERNATIVES

Dentists must share evidence and explain rationales behind selecting a bone graft material for a given clinical scenario as the superior or best choice. Through a mindfulness approach, providers can not only understand the patient’s perspectives but also underscore scientific reasoning behind their recommendations. In some cases, a bone graft material that may be rejected by the patient could have, in fact, a better potential treatment outcome. For instance, a 2020 study by Wychowanski and colleagues revealed that xenografts may provide greater benefits to patients receiving chronic immunosuppression therapy, with lower complication rates than autogenous bone blocks for vertical bone augmentations before implant placement. According to a Cochrane systematic review, Cerabone (Botiss), a bovine bone xenograft, is comparable with autografts in treating severe maxillary alveolar atrophy. In the maxillary alveolar reconstruction of unilateral cleft lip and palate conditions, the alloplastic material recombinant human bone morphogenic protein-2 showed equal effectiveness as traditional autografts. A systematic review by Alyahya and Swennen concluded that all classes of bone grafts had comparable performance in orthognathic surgeries; however, calcium phosphate and hydroxyapatite alloplastic materials had increased postsurgical infection rates.

Dentists must judge appropriately and streamline the available evidence in an unbiased manner before presenting it to the patient. Educating patients about the risks and benefits of graft materials will encourage a shared decision-making process between the dentist and patient. For patients who are opposed to using xenografts or allografts, alternatives such as autografts or alloplasts may be presented, provided that dentists explain the advantages and disadvantages of each specific graft type. However, practitioners must consider carefully factors such as evidence-based clinical performance, feasibility (specifically for autografts), anticipated treatment outcome, operator expertise, and cost of the graft material before recommending the bone graft options.

Although dentistry is not entirely devoid of animal-based products, efforts to be inclusive of the vegan community are underway, and with advancements in technology and innovation, vegan-friendly dentistry might not be far off. Synthetic polyester membranes can be suggested as alternatives to the traditional bovine- or porcine-derived collagen membranes in patients who do not want animal-derived materials. These synthetic membranes usually contain medical grade aliphatic polylactides like polylactic acid, polyglycolic acid, poly-caprolactone, and their copolymers, such as polyactic glycolic acid (PLGA), and are free of animal derivatives. Newer bioabsorbable and biodegradable synthetic PLGA membranes such as Tisseos (Biomedical Tissues SAS), Biomesh-S (Samyang Holdings), and Gore Resolute Adapt (W.L. Gore and Associates), have been introduced commercially as alternatives to traditional collagen membranes. Polyester membranes degrade in vivo through the process of hydrolysis, and, therefore, the resorption rate of these membranes can be controlled via altering the hydrophobicity of the polymer, making them good candidates for guided bone regeneration.

For instance, the bilayered PLGA Tisseos membrane takes a longer time (up to 26 weeks) to hydrolyze in vivo, with a persistent barrier effect lasting up to 16 weeks compared with collagen membranes that typically last up to 8 weeks in vivo. They are considered clinically safe and predictable for use in guided bone regeneration, with a greater controlled resorption.
rate and performance comparable with that of traditional animal-derived collagen membranes.\(^3\),\(^31\)

**CONCLUSIONS**

Before using bone grafts in patients, dentists should consider patients’ religious, humanitarian, and personal values to ensure that dentists do not neglect patients’ opinions. Furthermore, dentists need to inform patients about the bone graft composition and rationale for use. To advance our profession and enhance dental patient experience, we should be adaptive to the patient’s needs and desires, but the selection should be on a scientific basis without any bias.

Dr. Gill is a general dentist and a research assistant, Department of Clinical Preventive and Restorative Dental Sciences, School of Dentistry, University of California San Francisco, 707 Parnassus Ave, Box 0758, San Francisco, CA, 94143, email sukhi@gill93@gmail.com. Address correspondence to Dr. Gill.

Dr. Prakash is a general dentist and a research assistant, Department of Preventive and Restorative Dental Sciences, School of Dentistry, University of California, San Francisco, San Francisco, CA.

Dr. Forghany is a general dentist and a research assistant, Department of Preventive and Restorative Dental Sciences, School of Dentistry, University of California, San Francisco, San Francisco, CA.

**Disclosures.** None of the authors reported any disclosures.

---


