Retromolar bone grafts prior to implant placement

Outcomes and complications—Part II

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_Introduction

The dental rehabilitation of partially or totally edentulous patients with oral implants has become common practice with reliable long-term results.[1] However, unfavourable local conditions of the alveolar ridge due to atrophy, periodontal disease, trauma sequel, malformation or neoplasia may cause insufficient bone volume, which may complicate the therapy of the masticatory function with dental implants.[2] When alveolar ridges lack the appropriate bone volume, additional surgical reconstructive procedures are required. This article concludes Part I (implants 3/2013) with results, an extensive discussion and the conclusion.

_Results

One hundred and four retromolar bone graft procedures were performed in 86 patients, 77 men and nine women, with a mean age of 37.9 (range 20.2–58.4 ±10.78 years). Of the 86 patients receiving grafts, 29 were smokers (Fig. 1). Seven patients were pre-diagnosed with general-advanced periodontitis, which was successfully treated before bone grafting and one patient with diabetes mellitus Type II.

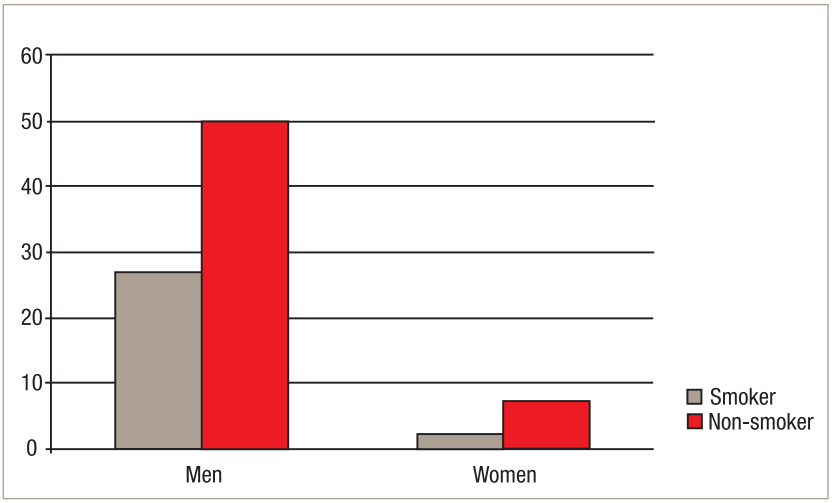


Fig. 1_Separation of the patients in men and women, according smoking habit.

Twenty-two procedures involved the maxilla and 82 the mandible. Also, fifteen patients were treated multiply in different alveolar sites. Regarding the alveolar crest situation, 32 cases were recorded as free-end situation, 27 as multiple teeth gap and 39 as single teeth gap. These as well as the intraoral area separation are presented in Table 4. In ten patients, two bone blocks were harvested in one single augmentation position.

Of the 104 onlay bone grafts, 81 (77.8%) were defined absolutely successful and 23 (22.2%) had minor adverse effects, such as incision-line dehiscence, swelling or wound infection with pus exit, or temporary paraesthesia. Only eight grafts (7.6%) in seven patients were defined as failures (i.e. graft exposure and screw mobilization). Of all the areas with complications, 15 were defined in the donor site, 23 in the recipient area and in four patients experienced complications in both donor and recipient site.

Regarding postoperative swelling following the bone grafting procedure, most of the patients suffered a minimal facial deformity lasting not longer than three days. Swelling was otherwise an expected complication after surgery. At two weeks after the operation, none of the 86 patients reported persistent pain. There was no significant association between periodontitis and complications ($p = 0.43$) (Fig. 2). There was also no relation between complications or failure rates of the recipient site and jaw areas ($p = 0.21$) (Fig. 3).

No major complications were observed regard to donor sites. One patient developed a wound infection with exit pus, and two patients developed an abscess, which had to be opened surgically in local anaesthesia.

No incision-line dehiscence occurred in the donor site areas. Eleven patients mentioned sensory deficits in the lower lip and mental foramen area and three of them experienced altered sensation in the mental and lower lip area as well as in the tongue. None of the patients experienced altered sensation localised in the region of the buccal nerve terminal branch. The incidence of temporary mental nerve paraesthesia was 10.5% (11/104). At the time of implant insertion, there were no reports of symptoms other than the persistence of altered sensation in two patients who had reported pareasthesia during suture removal. One of the patients experienced postoperative bleeding and was treated with local haemostasis (Tab. 5). A relation between smoking or medical history and complications of the donor site is not possible, because these incidents are usually caused iatrogenically.

In the ten patients who underwent impacted third molar tooth extractions combined with bone harvesting, a temporary paraesthesia or wound infection were observed in six of them. In the recipient sites, the frequency of complications was higher than in donor sites. Except the minor complications such as wound infection with pus exit or incision-line opening, graft exposure and screw mobilization as well as combinations of them (Tab. 6). In Figure 4, some complications in recipient sites are presented.

Seven (31.8%) of them were observed in smokers and 15 (68.2%) in nonsmokers in a total of 22 bone grafts. The temporary paresthesia on the percipient site observed by one patient was not taken in consideration. Figure 6 presents the separation of the postoperative complications both of the donor and recipient site according to smoking. Statistic significance between smoking and complications was to be considered ($p = 0.009$). In one diabetic patient, loss of bone particles after infection was observed and no implantation was realizable. Wound infection and graft exposure were also observed in two patients with preoperatively diagnosed general-advanced periodontitis. However, no association was found in this study between retromolar bone grafting complications and medical history, because of the low number of patients.

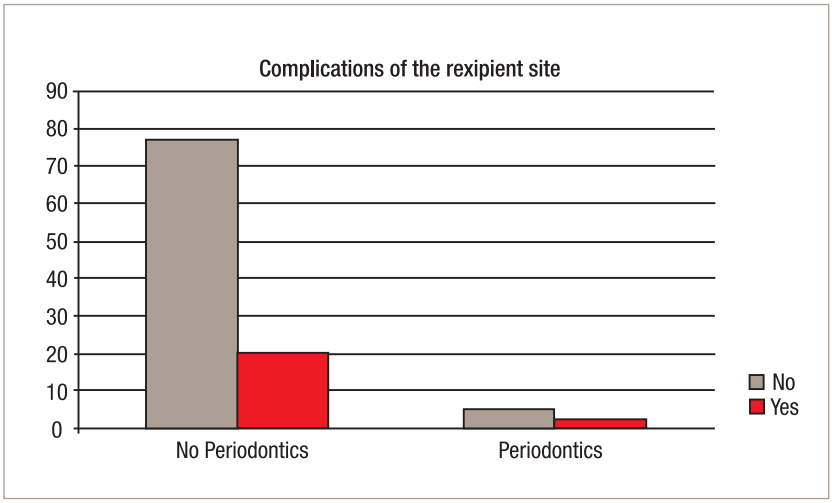


Fig. 2_Association between periodontitis and complications of the recipient site.

A great value was given to the management of the postoperative complications. Minor effects were treated conservatively with mouth rinse included chlorhexamid and antibiotics either orally or intravenously. Patients with abscess had to be treated surgically and were also covered with antibiotics. By graft exposure, the bone sequesters were removed and the bone block was refreshed, while the wound was closed with a buccal fat pad under antibiotic cover. By patients with screw mobilization, healing was uneventful after the removal of the screw. In eight (7.6%) of the cases, the bone graft was totally exposed combined with wound infection and exit of pus. The surgical removal of the graft was

Table 1_Complications associated with retromolar bone grafts.

Complications	Etiology	Prevention	Management
Infection, membrane contamination	Microbial contamination	Antibiotics and aseptic surgical procedure	Remove infection source, systemic antibiotics and antimicrobial mouth rinse
Incision line opening, membrane exposure, wound dehiscense, perforation of mucosa	Tension-free closure not achieved	Achieve tension-free primary closure	systemic antibiotics and antiseptic mouth rinse
Nerve dysfunction	Damage to infra-alveolar nerve		Know the anatomy, wait and sometimes palliative treatment may be needed
Graft mobilization	Inadequate fixation (insufficient screws, screw loosening)	Secure fixation screws, use >1 screw, ensure no-mobility and no dead space principle	Remove and regraft at later time
Loss of bone graft particles	Primary closure not achieved	Achieve tension-free primary closure, use of membrane	Do nothing and allow for proper healing

Autors	No. of patients	Reported complications
Girdler & Hosseini 1992	12	Temporary lingual paraesthesia
Raghoebar et al. 1996	7	none
Von Arx et al.1996	4	none
Misch 1997	19	Incision dehiscence
Schlegel et al. 1998	5	none
Von Arx et al. 1998	13	Hypoaesthesia n. V3, massive postop. bleeding
Cordaro et al. 2002	15	Bone resorption
Clavero 2003	24	Hypoaesthesia n. V3
Schwartz-Arad 2005	10	Graft exposure, Hypoaesthesia n. V3
Schwartz-Arad 2005	18	Incision dehiscence, Graft exposure, Hypoaesthesia n. V3

Table 2_Review of the literature on harvesting of retromolar bone grafts.

then inevitable. The wound healing was subsequently uneventful, but there was not enough bone for insertion of implants. A second augmentation procedure was then performed in only two cases. The patients with temporary paraesthesia by the suture removal always had control appointments until the healing of their nerve dysfunction (Tab. 7).

Bone resorption was easily visible on removing the osteosynthesis screws since the heads of the screws were always 1 to 2 mm above the grafted bone. On re-opening, the shape of the grafted block was rarely visible in most of the cases. Of the 104 bone reconstructions, 19 (18.2 %) required simultaneous augmentation at the time of dental implant placement.

The average healing period after bone harvesting was 125.8 days or 4.49 months, ranged from 91–276±66.23 days. 155 dental implants were placed, 39 in the maxilla and 116 in the mandible. All these implants were placed using the CoDiagnostiX® (IVS Solutions AG) program for guided surgery. All the implants were integrated at the abutment connection. To date (mean of six months after prosthetic loading) all the implants were successful, according to the Albrektsson criteria.[62] In eight of the cases (7.6 %), implant installation was not possible due to insufficient bone after augmentation procedures. Despite the complications, a significantly higher loss of bone grafts was not found. After the prosthetic rehabilitation, the oral function was completely re-established in all patients.

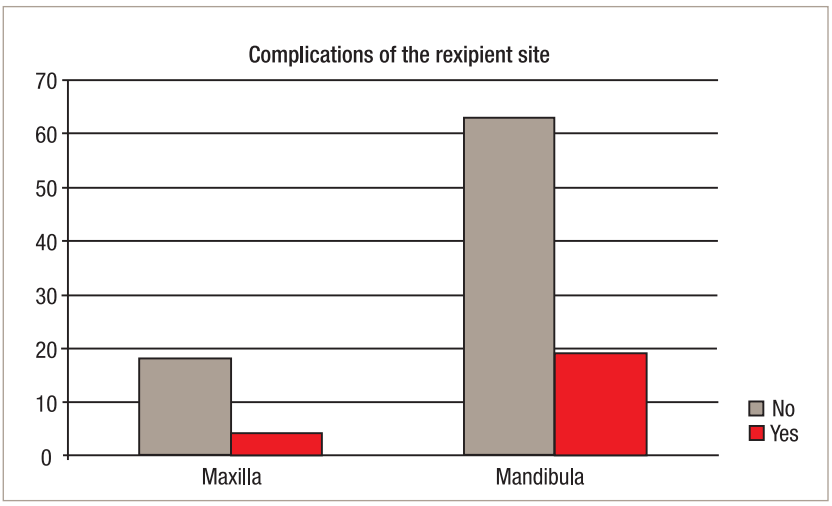


Fig. 3_Association between jaw and complications of the recipient site.

_Discussion

The use of endosseous implants may be limited by insufficient quality and quantity of available bone. Several grafting procedures have been described to create sufficient volume of bone for implant placement.[33] Autogenous grafts still remain the "gold standard" in reconstructive surgeries due to their osteoinductive, osteoconductive, and osteogenic potential, essential for bone morphogenesis.[34-35] Serra e Silva et al. conclude that autogenous bone grafts are the best option compared with allografts and xenografts due to its properties and constitute a viable form of treatment for patients with alveolar bone loss.[36] The placement of implants into healed bone grafts as a secondary procedure is similar to their use in jaws that have not been grafted.[37]

Several studies have reported on harvesting of grafts from the retromolar region.[13, 20, 22, 24, 26, 28] However, the number of complications is discordant when the different trials are compared. This seems to be because none of the studies is prospective and based on objective tests for the function of inferior alveolar and lingual nerves. Advantages of retromolar bone grafts are the use of local anaesthesia instead of general ansesthesia, no need to stay in hospital postoperatively, less morbidity at the donor sites, and lower costs.[38, 39] A disadvantage is the small volumes of bone offered.

Performing ridge augmentation and implant placement as two-stage surgery is still said to be more successful than the single-stage procedure.[31, 40] A healing period for mandibular grafts of four months has been recommended.[5, 13, 31] There is experimental evidence that grafts from membranous bone show less resorption than endochondral bone due to early revascularization, better potential for incorporation in the maxillofacial region because of a biochemical similarity in the protocollagen, and the inductive capacity is greater because of a higher concentration of bone morphogenetic proteins and growth factors. The early revascularization seems to explain the good maintenance of volume of the retromolar graft.[41] However, a major disadvantage of retromolar grafts remains. Only a confined amount of bone can be harvested from this donor

site. It has been described that the volume is half of what can be achieved from the mandibular symphysis.[13] The dense structure of cortical portion of the grafts offers the benefit of improved implant stability during placement and healing and may even improve interfacial stress transmission on implant loading.[5, 30, 42]

The aim of this study was to report clinical results of alveolar ridge augmentation in partially edentulous patients prior to implant placement, using bone blocks from the retromolar region and firmly secured to the recipient site with osteosynthesis screws with the use of barrier membranes. The clinical indication for the procedure was the lack of sufficient alveolar bone, a situation that could interfere with the correct placement of implants of the desired length.

In this retrospective study, the data reported were readily collected from the authors after the postoperative phase. The sample studied was small and the augmented sites differed in location and type of defect. In the absence of a control group, the statistical significance of the means calculated was not tested. A new surgical devise with piezoelectric ultrasonic generator (Mectron, Deutschland Vertriebs GmbH) recently developed, offers an alternative way of safely removing hard tissue without damaging soft tissue and is a useful tool of harvesting procedures from the ramus.

Barrier membranes have been used to achieve alveolar ridge augmentation in implant surgery in a staged approach, or at the same time as implant placement.[6, 10, 43] The use of barrier membranes in combination with particulate grafts and implants to augment the alveolar ridge and obtain ideal positioning of implants is reported to be an effective procedure in both humans and experimental animals.[6, 31, 44] The use of barrier membranes over particulate bone grafts seems to reduce the tendency for bone graft to be reabsorbed during the healing phase. It must be pointed out that the tendency of bone grafts to resorb during the healing phase also occurs if the graft is protected by a membrane and no complications arise.[6] However, the use of barrier membranes generally may be followed by soft tissue dehiscence, membrane exposure and plaque colonization and, in very few cases, by the need to remove the barrier. This complication jeopardizes the whole procedure.[45-46] According to Buser et al (1996), if a staged approach is used, complications involving membrane exposure, suture dehiscence and loss of the graft are minimal.[6]

Fixation of an onlay graft to the recipient site can influence the revascularization of a graft.[47] A loose graft may become nonunioned and encapsulated. Fixation screws for the onlay graft should be tightened to ensure close adaption. Infection is usually a consequence of poor aseptic control of the surgical field. Rinsing with chlorhexidine before surgery is a preventive measure to reduce the risk of infection. Tension-free flap closure is essential so exposure of the membrane or fixation screws can be prevented.[48]

Etiology	N
Caries/Periodontitis	97
Trauma	3
Hypodonty	4
Total	104

Table 3_Etiology of tooth lost.

Alveolar ridge Situation/ jaw	Maxilla	Mandibula	Summary
Free-end situation	7	30	37
Multiple teeth gap	12	16	28
Single tooth gap	3	36	39
Summary	22	82	104

Table 4_Distribution of alveolar ridge situation and jaw separation prior to implant placement.

Type of complication	N
Wound infection with pus	1
Swelling/abscess	2
Hypoesthesia N. mental	11
Hypoesthesia N. mental and lingual	3
Postoperative bleeding	1
Total	18

Table 5_Type and number of post-surgical complications in donor sites.

The limits of the retromolar area are dictated by clinical access, as well as the coronoid process, molar teeth, and inferior alveolar canal. A rectangular piece of bone up to 4 mm in thickness may be harvested from the ramus. This morphology conforms especially well as a venner graft to gain additional ridge width.[49]

A vestibular incision that extends well beyond the mucogingival junction creates easier access but produces more soft tissue bleeding and intraoral scar formation. Haemostatic materials are placed into areas of osseous bleeding, and postoperative pressure dressings reduce the development of haematoma formation, incision line dehiscence and infection. The use of glucocorticoids is helpful in reducing postoperative oedema.[50-52] The ramus graft patients appeared to have fewer difficulties in managing postoperative oedema and pain.

Pain is also reduced in the first day after surgery. No adverse effects for single dose or a negative effect on

Table 6_Type and number of postsurgical complications in recipient sites.

Type of complication	N
Incision line opening	4
Swelling/wound infection with pus	6
Swelling/abscess	4
Graft exposure	1
Wound infection with pus und graft exposure	5
Graft exposure und screw mobilization	2
Hypoesthesia N. infraorbital	1
Total	23

wound healing have been reported. Since our patients were sent home a day after the end of the bone grafting procedure, our aim was to reduce swelling as much as possible. Intraoral or intravenous antibiotic therapy postoperative was not given. There is no evidence that prolonging antibiotic therapy after the first day gives additional protection if antibiotic prophylaxis is correctly prescribed.[47] Besides these considerations, many surgeons when using bone grafts or membranes describe the use of intraoral antibiotics for a period varying from three to ten days postoperatively.[6, 53]

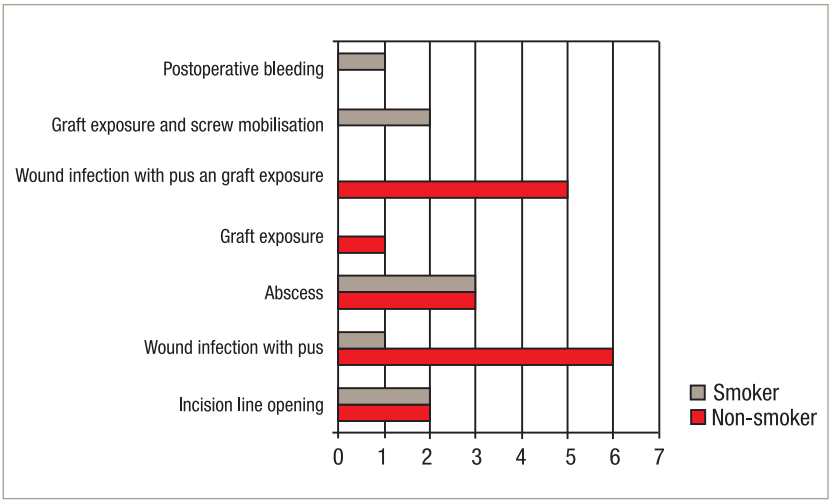
The potential for damage to the inferior alveolar nerve, as opposed to its peripheral mental branches, is of greater concern with the ramus graft technique. To prevent nerve injury, harvest of bone from this area requires knowledge of the mandibular canal anatomy. Although the position of the canal is variable, anatomic averages are helpful in surgical planning. The mean anteroposterior width of the ramus is 30.5 mm, with the mandibular foramen located about two thirds of the distance from the anterior border.[54, 55]

The mean vertical distance between the superior edge of the canal and the cortical surface along the external oblique ridge is approximately 7 mm in the second molar region, 11 mm in the third molar region, and 14 mm at the base of the coronoid process.[55] Although the buccolingual position of the mandibular canal is variable, the distance from the canal to the medial aspect of the buccal cortical plate (medullary bone thickness) was found to be greatest at the distal half of the first molar (mean = 4.05 mm).[55] Therefore, when larger grafts are planned, the anterior vertical bone cut should be made in this area.[56] Damage to the neurovascular bundle could also occur during sectioning of the graft. Care must be taken to parallel the lateral surface of the ramus when using the thin chisel along the external oblique osteotomy. If the inferior ramus cut is below the level of the inferior alveolar canal, graft separation should not be completed until it can be ascertained that the neurovascular bundle is not entrapped in the graft. Sometimes, the exposure of the inferior alveolar nerve is accompanied by massive bleeding, because of injury to the inferior alveolar artery.[22]

Patients were less able to discern neurosensory disturbances in the posterior buccal soft tissues than in the lower lip. Although the incision along the external oblique ridge could possibly damage the buccal nerve, reports of postoperative sensory loss in the buccal mucosa are rare, and most go unnoticed by the patient.[57] No specific treatment was required, and all patients recovered completely.

It is noteworthy that the failure rate was, in reality, lower because graft exposure was considered as failures, even though part of the graft remained intact in most of these cases. Leaving part of the exposed graft in place usually was adequate to allow sufficient bone for implantation.

Fig. 4_Incidence of complications noticed in donor and recipient sites according to smoking.



Generally, patients who suffer from diabetes show significantly higher failure rates and have more postoperative complications. Since diabetes increases the risk of infection and delays wound healing, it is possible that this kind of ridge augmentation is not suitable for these patients. A significant failure of diabetics in this study was, because of lack of fails, not presentable. However, more research should be conducted to determine how to perform a harvesting procedure in diabetic patients without the risk of graft failure.[58] Smokers demonstrate a high failure rate and more postoperative complications.[59] Smoking was found to impair the revascularization of the bone in regenerative procedures such as bone grafting, mainly due to its effect on vasoconstriction of the artery.[59] The altered oral flora from smoking increased the infection rate by two to three times in smok-

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Bone graft removing	6
Abscess-incision and antibiotic i.v.	3
Re-bone harvesting	2
Abscess-incision, wound-freshening and antibiotic i.v.	1
Haemostasis	1
Total	26

Table 7_Management and surgical treatment of the postoperative complications after retromolar bone grafting.

ers, which adversely influenced the complications of bone grafting procedures.[60] Patients with history of smoking have a higher failure rate of implants, regardless of the amount of cigarette consumed.[61] Association between retromolar bone grafting complications and smoking habits was also found in this study. Dentists, oral surgeons and treating physicians should urge their patients to quit smoking since it reduces the success rate of ridge augmentation. Higher implant failure rates have been reported when implants are placed into grafted sites.[22] However, in this study, despite the number of complications, rehabilitation with oral implants was not possible in only 7.6 % of all bone grafting procedures. Aghaloo and Moy have already indicated similar success rates between implants placed into grafted sited compared with implants placed into native bone.[38]

Small amounts of particulate bone grafts may be collected from the implant area during implant site preparation, and the resulting bone chips can then be used to fill small defects. The main disadvantage of this technique is the contamination with oral bacteria. In accordance with Chiapasco, only bone blocks maintain the architecture of bone and appear to adapt easily to the recipient area, whereas particulate bone grafts were associated with bone blocks in case of simultaneous grafting procedures or as a filling material around or between bone blocks.[2] Reports on simultaneous bone grafting and implant placement have revealed complications such as graft fracture and wound dehiscence with exposure of implants and graft, with a higher implant failure rate than that of a staged approach.[15, 27, 29, 42]

A staged surgery permits implant placement for ideal prosthetic alignment without the concern of graft fixation or remodelling.[56] Staged implant placement also allows for any initial graft resorption and thus should provide a more stable foundation. None of the complications influenced the success of rehabilitation significantly. Despite the need for two surgical procedures, the patients were compliant with the entire treatment. Not only was the planning a key factor of every successful case, it was also essential to learn exactly what the patient expected from the surgery and to design the surgical procedure to achieve that goal.

_Conclusion

The clinical data presented in this study showed that onlay block grafts harvested from the retromolar region are a safe, effective and simple method of treating localized alveolar ridge hypoplasia in partially edentulous patients for implant placement. It must be considered that the postoperative phase of stage-one surgery is comparable to the discomfort felt following major dentoalveolar surgery and that the procedure can easily be carried out in an outpatient environment. The risks and morbidity of retromolar bone grafting can be associated with some complications, which do not significantly compromise rehabilitation when appropriate treatment is established.

This retrospective study of bone grafting surgeries can serve as a guide in the prevention of possible failures and consequently improve the quality of future procedures. More studies to determine which donor sites provide sufficient bone with the least patient discomfort and risk of complications are needed. Additional studies are needed to evaluate the long-term results of the described method with regard to implant stability and resorption of bone around the implants._

Disclosure
The authors do not have any financial interests, either directly or indirectly, in the products listed in the study.

Editorial note: A list of references is available from the publisher.

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