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Fate of Osteochondral Grafts

Anthony F. DePalma, MD, Blackwell Sawyer MD, and J. David Hoffman MD, CORR 1962;22:217–234

Surgeons have attempted grafting bone since antiquity, with the earliest references from Hindu, Greek, and Egyptian texts [2]. However, grafting cartilage in one form or the other, is apparently of more recent origin, with experimental studies in the late 1800s [24]. Ollier [21] likely conducted the first experiments to graft cartilage. According to Keith [12], Ollier found cartilage with perichondrium attached survived but the graft never produced cartilage. Lexer, in 1908, used whole joint transplants including articular surfaces for damaged joints [15, 16] but with questionable success. Various isolated costal cartilage grafts were later successfully used to repair cranial defects mostly associated with injuries suffered in World War I [20, 23, 25]. However, clinical use of osteochondral grafting is of more recent origin. Moore, in 1948 [18, 19] described a novel autograft to be used in ununited femoral neck fractures. He removed the femoral head, reamed out all but a thin layer of bone (no more than 1/8 inch), then reamed the femoral neck to fit the osteochondral portion of the head. He performed the procedure in 19 patients, 11 of whom he followed for 1 to 9 years, and claimed “excellent results” in nine of those patients.

DePalma et al., in 1962 [4], described experimental studies of Moore’s procedure; these studies were perhaps among the earliest critically examining

osteochondral grafts. “Our purpose is to record the fate of autogenous, fresh homogenous and plasma-stored homogenous osteochondral grafts when they are placed in a physiologic position of function.” In these studies 30 dogs had autografts from the other hip (in which was implanted an acrylic prosthesis), 30 had fresh allografts, and 30 had plasma-stored grafts. They sacrificed the animals at numerous times between 6 and 400 days. Owing to various complications, they were able to study 21 of the first group of animals, 19 in the second, and 22 in the third. The authors concluded, “The cartilage of autogenous grafts survives, but we have no definite evidence that it proliferates. Cartilage of fresh homogenous grafts also survives, but old specimens exhibit areas of degeneration, especially of the superficial layers. These abnormalities may be mechanical in origin. Cartilage of plasma-stored grafts eventually undergoes complete disintegration. These results suggest that under clinical conditions autogenous transplants of articular cartilage and cortex can succeed in a higher percentage of cases; a smaller and an unpredictable number of homografts can also perform some function.” In a followup study where S35 was injected at periods from 3 months to 1 year to determine uptake in the chondrocytes [5], DePalma and his colleagues concluded, “The cartilage portion of the autogenous grafts survived for one year, the duration of the

experiment, as demonstrated histologically and by the ability of the transplanted chondrocytes to metabolize S35 when injected into the host. These cartilage grafts did not lose bulk.”

Osteochondral grafting, using mostly allografts, is still occasionally used for tumors [3, 7], severe knee trauma [9], or chondral defects [13] and osteochondritis dissecans (the subject of this issue’s symposium) [6, 17]. Alternative approaches to repairing these defects including attempts to bring stem cells into the local area via drilling through subchondral bone [11, 14] or microfracture [10, 26], or implantation of “tissue engineered” constructs of carriers with cells and/or growth factors [1, 8]. As stated by DePalma et al., the question remains the fate of the grafts: while the bony elements typically are replaced with new bone, do the chondrocytes survive and do these grafts durably function over many decades? Contemporary allografting research has focused on improving storage processes to enhance chondrocyte viability in the grafts [22, 27]. While likely important to ultimate durability of the grafts, high chondrocyte viability at the time of implantation does not ensure continued viability and normal function after implantation. Some of these grafts do survive and function long term [7, 9], but survival likely relates in part to immunologic [7] and mechanical

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factors. It remains unclear how many will be durable over decades and what factors determine such durability in these mostly young patients. These questions remain in part because the population is largely young, mobile, and hard to follow, the specific indications variable, and the conditions sufficiently uncommon that no single institution can gather a large enough cohort of similar patients. While reviewing earlier attempts to successfully graft bone, Sir Arthur Keith, in 1919, commented, “The history of human invention is ever the same: we find that the path which led to final success is always strewn with the wreckage of efforts which failed” [12]. Despite many failures (most of which have likely never been recorded), osteochondral grafting remains a valuable treatment option, particularly in young individuals where the alternatives of joint replacement or fusion may be delayed many years.

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