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Insulation of simultaneous arterial and nerve repairs in the rat: the effectiveness of the autologous vein graft

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Abstract

The use of a vein graft as a barrier between arterial and nerve repair sites has not been reported previously. The aim of this study is to present the possible use of the vein graft for insulating a nerve repair site from an adjacent arterial anastomosis. Bilateral longitudinal incisions were created on 5 Sprague-Dawley rats. Bilateral nerve coaptations and femoral artery repairs were performed. The left nerve repair site was wrapped with the vein graft obtained from the ipsilateral femoral vein. At the postoperative second month, the repair sites were visually evaluated. Blunt dissection between the nerve and the artery was performed and specimens were obtained for histopathological evaluation. There were no signs of absorption or degradation of the graft under the operating microscope. Minimal adhesions were noticed between the vein-wrapped nerve and the artery. In the vein-wrapped side, mechanical dissection was significantly easier. Histopathological evaluation revealed sufficient insulation of the nerve from the artery repair site. Vein grafts can be used in order to prevent adhesions between repair sites of adjacent injured structures. Despite the favorable results achieved in this model, we do not urge the routine use of this method in every clinical situation. However in a clinical setting that an extensive fibrosis is expected, such as combined and multiple injuries affecting tendons, nerves and arteries, we believe the technique has a place as a favorable adjuvant procedure.

Key words: [vein] [graft] [nerve] [artery] [repair] [microsurgery]

Introduction

The control of postsurgical scar formation has been the goal of nerve surgeons and researchers for many decades. Interposition materials have been tested to prevent postoperative adhesions between nerves and surrounding tissue in various clinical settings [1–3]. In recent years, the autologous vein graft has earned an ample popularity between the peripheral nerve surgeons.

The technique of vein wrapping was first described by Masear and Colgin [4]. Since then, numerous studies have been reported regarding the use of the technique in order to prevent scar formation around nerves, both in experimental models and clinical settings, using autologous and allograft materials [4–11]. However, the use of the vein graft as a barrier between an arterial anastomosis and a nerve coaptation site has not been reported previously. In clinical practice, the incidence of combined injuries, especially in the upper extremity, is reported to be high [12]. A simultaneous repair of an artery along with a neighboring nerve usually produces a thick zone of fibrosis between the repair sites (Figure 1). This carries a potential risk for the arterial repair when a second look is required, such as a neuroma formation in the nerve requiring secondary surgery. For this reason, insulation of the nerve from the artery by means of an interpositional material seems to be logical. The results of the studies with vein-wrapped nerves that have reported limited scar formation encouraged us about the possibility of using this technique.

The aim of this study is to investigate the possible use of the vein graft for insulating a nerve repair site from an adjacent arterial anastomosis.

Materials and Methods

Animal Ethical Committee approval was obtained for this study. Under intramuscular ketamine (10 mg/kg) and sodium pentobarbital (18 mg/kg) anesthesia, the femoral regions of 5 Sprague-Dawley rats, weighing 375 to 400 gr, were prepared. Bilateral longitudinal incisions of 2.5 cm length were created. The femoral artery, vein and nerve were exposed. Bilateral femoral nerve coaptations and artery repairs were performed using the operating microscope. The left femoral nerve repair site was wrapped with the vein graft obtained from the ipsilateral femoral vein (Figure 2). The vein was longitudinally opened and wrapped around the coaptation site in a spiral fashion (Figure 3) as previously described by Masear and Colgin [4] (Figure 4).

At the postoperative second month, three rats were anesthetized once more in order to visually evaluate the repair sites. A mechanical blunt dissection between the nerve and the artery was performed, as in a real clinical setting. The longitudinal mobility of the nerve was also tested. Two rats were killed by anesthesia overdose and the specimens were obtained for histopathological evaluation.

Results

At the time of the second look and harvesting, the vein graft could be identified under the operating microscope. There were no signs of absorption or degradation of the vein graft in any animal. Minimal scar tissue or adhesions were noticed between the vein-wrapped nerve and the artery. In the vein-wrapped side, mechanical dissection between these structures was significantly easier and better longitudinal nerve mobility was observed. The vein could be easily unwrapped from the nerve repair site (Figure 5). Histopathological evaluation revealed sufficient insulation of the nerve from the artery repair site without any problematic adhesions (Figure 6).

Discussion

In a real clinical setting, adhesions between the arterial anastomosis and the coaptation site of a nerve significantly reduce the possibility of a second look operation because of extreme fibrosis formation. A similar problem can be encountered when a flexor tendon repair is also performed at the same site since immobilization is usually needed when combined tendon, artery and nerve repairs are simultaneously performed (Figure 1). The safety of an autologous vein graft wrapped around a nerve, as a potential wrapping material, has been proved in previous studies [4–6, 9–11, 13]. The researchers usually studied the potential use of the graft in intact nerves in the rat sciatic nerve model. However, since we were interested in insulating the nerve from an arterial repair, a region where both structures neighbor each other should be selected. The femoral artery and nerve were ideal for this purpose.

The ideal wrapping material would be able to protect the nerve from compression by surrounding scarring, inhibit the formation of adherent scar to surrounding tissue, improve or protect the gliding function of a nerve during

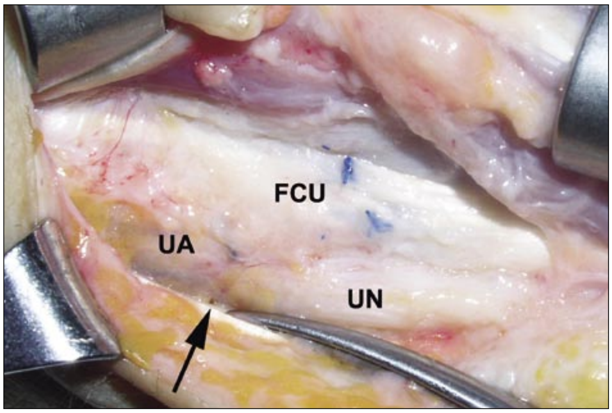

Figure 1. Repaired combined injury of flexor carpi ulnaris tendon (FCU), ulnar nerve (UN) and ulnar artery (UA). The arrow indicates the repair site for the nerve and artery which are in close approximation. Note the extensive fibrosis that significantly impairs dissection.

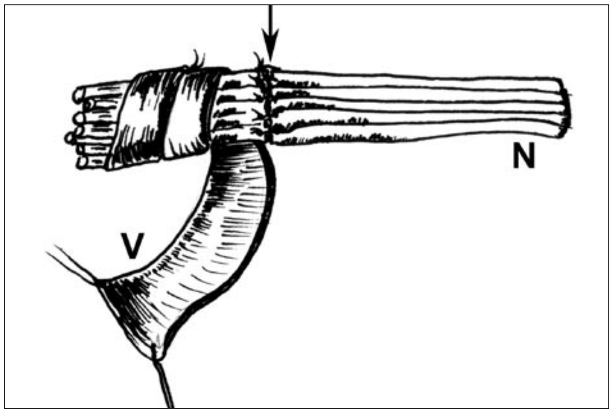

Figure 3. Illustration of the spiral vein wrapping technique *a la* Masear and Colgin [4]. The arrow indicates the coaptation site *(**V:** vein, **N:** nerve).*

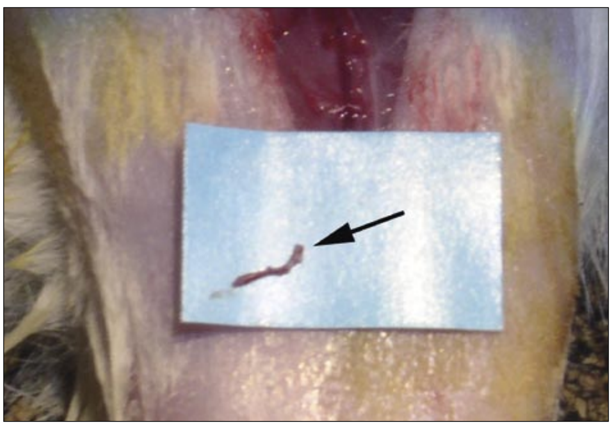

Figure 2. The harvested femoral vein (arrow). The vein is opened longitudinally before wrapping around the nerve.

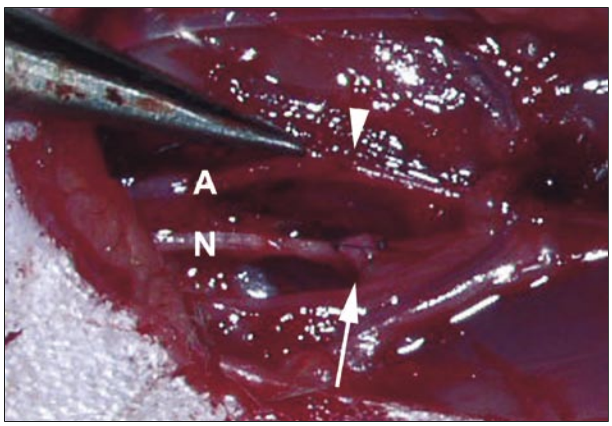

Figure 4. The appearance of the femoral region at the end of the procedure. The arrow indicates the nerve coaptation site wrapped with the vein graft and the arrow-head indicates the arterial anastomosis site *(**A:** artery, **N:** nerve).*

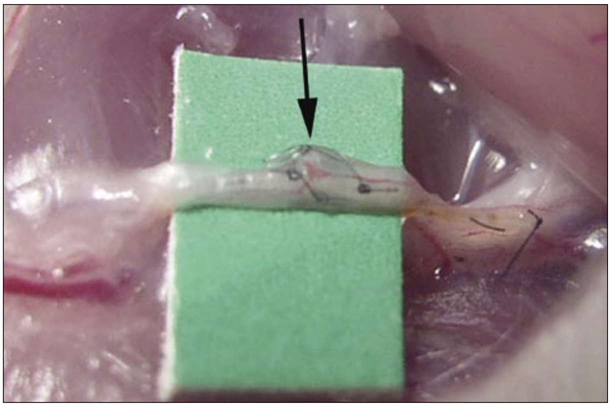

Figure 5. The nerve repair site at the end of 2 months. The arrow indicates the easily unwrapped vein graft.

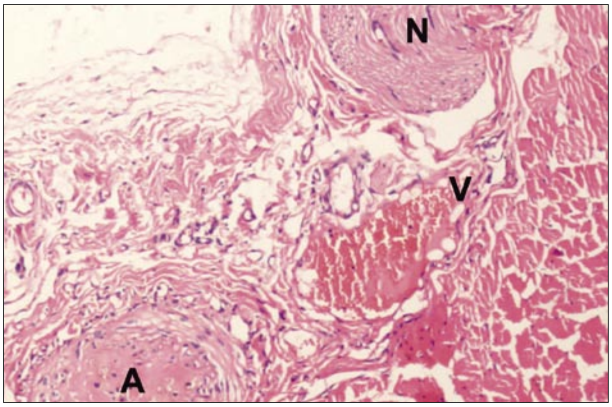

Figure 6. The sufficiently insulated nerve (N) from the artery (A) via the vein (V) graft in histological evaluation (H&E, X40).

extremity motion. It should also resist degradation, minimize any inflammatory and immunologic reactions, and not be responsible for long-term compression of the nerve. The characteristic features of vein grafts that meet these criteria have been well documented previously [6]. From the results of our study, vein wrapping (as a nerve barrier material) also appears to have a good potential for the insulation of repair sites of arteries and nerves. This is the first report of the possible use of this material in this setting. The vein with its intact and smooth endothelial surface, may play an important role in enhancing the gliding between the nerve and the vein and in decreasing adhesion of the nerve to the surrounding tissue. This will avoid the possible damage induced by gliding friction of the nerve trunk. Thus, the protection provided by the graft may result not only from its barrier effect but also from a favorable internal interface between the vein and the nerve [6, 10]. However, the exact mechanism of this effect remains uncertain [11].

Masear and Colgin [4] have described 2 methods of vein wrapping: a spiral and a sleeve pattern wrapping. We have preferred to use the former method which is much easier to apply (Figure 3). Further, it is also easier to control the tightness of the vein graft around the nerve via this technique [6]. The possibility of the use of the material in the inhibition of neuroma formation needs further studies [13]. However till then, vein grafts can be used in selected clinical settings in order to prevent adhesions between repair sites of adjacent injured structures. Despite the favorable results achieved in this *in vivo* rat model, we do not urge the routine use of this method in every clinical situation. However in a possible setting that an extensive fibrosis is expected, such as combined and multiple injuries affecting tendons, nerves and arteries, we believe the technique has a place as a favorable adjuvant procedure.

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