Augmenting Occupational Therapy Treatment of Upper-Extremity Spasticity With Botulinum Toxin A: A Case Report of Progress at Discharge and 2 Years Later

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KEY WORDS
• botulinum toxin A
• hemiplegia
• spasticity
• stroke

This case report summarizes occupational therapy services provided to a participant after botulinum toxin A (BTA) injections and her improvements 2 years later. The injections were performed to neutralize spasticity in the left upper extremity after a stroke. Along with BTA, the participant received occupational therapy for 12 weeks, using neurodevelopmental and biomechanical approaches and an activity-based home program. Spasticity decreased from a 4 to a 1 on the Modified Ashworth Scale (MAS) immediately after the injections. Two years after the injections, the MAS score ranged between 1 and 1+. Initially, the participant demonstrated functional limitations in areas of splint application, dressing, toileting, and bathing. Following BTA injections and occupational therapy, the participant demonstrated increased independence in all deficit areas. For this participant, BTA, combined with functional, activity-based occupational therapy interventions, was associated with neurological change and greater functional use of the spastic limb.


Poststroke upper-extremity spasticity can be the cause of serious functional limitations, pain, and even infections because of skin and hygiene issues. These clients’ rehabilitation goals usually include increasing range of motion (ROM), improving positioning and function, and ensuring skin integrity (Bayram, Sivrioglu, Karli, & Ozcan, 2006; Hesse, Brandl-Hesse, Bardeleben, Werner, & Funk, 2001). Recently, botulinum toxin A (BTA) has been used in conjunction with therapeutic techniques to improve the agonist–antagonist balance and thereby improve function and decrease pain (Hoare & Imms, 2004).

Botulinum toxin A is a parenteral agent that is administered by a physician directly into the belly of a spastic muscle. It is derived from the organism that causes botulism, bacterium Clostridium botulinum, and is commercially known as BOTOX (Allergan, Inc., Irvine, CA). Although BTA is often thought of as a cosmetic drug, when injected into a spastic muscle, it works to block the release of acetylcholine and effectively causes a chemodenervation of the target muscles without adversely affecting the antagonist muscles (Koman, Smith, & Balkrishnan, 2003). The degree of denervation of the target muscle can be regulated by the physician on the basis of the number and dosage amounts of the BTA injections. The effects of the denervation last for 3 to 4 months, and clients can safely receive additional injections to maintain the desired level of denervation (Koppes, 1997). If the effects of BTA are not as desired after the first injection series, the dosage and location of the injections can be modified during the subsequent series of injections (Yablon, Agana, Ivanhoe, & Boake, 1996). Long-term use appears to be safe, and adverse reactions to BTA are rare as long as the recommended dosage amount is followed (Allergan, 2003;
Aunti-Ramo, Larsen, Taimo, & VonWendt, 2001; Bayram et al., 2006).

**Therapeutic Intervention and BTA**

BTA can be a vital component of a comprehensive rehabilitation program, but it should not be viewed as the only component (Koppes, 1997). Alone, it may decrease tone and improve passive range of motion (PROM), but it may not affect functional abilities (Kuijik, Geurts, Bevaart, & Limbeeks, 2002). For this reason, ROM and degree of spasticity should not be used exclusively to demonstrate improvement; rather, functional goals should serve as the mark for improvement. In recent studies in which participants received BTA injections and occupational therapy, those who received both BTA and occupational therapy demonstrated greater improvements in self-care and upper-extremity function than those who received BTA or therapy exclusively (Chin, Duncan, Johnstone, & Kerr, 2005; Fehlings, Rang, Glazier, & Steele, 2001). Therapeutic intervention is essential, and failure to provide this intervention is likely to result in a less-than-optimal outcome. BTA injections can be used in conjunction with many different treatment techniques. In occupational therapy, neurodevelopmental, biomechanical, and functional approaches may be effective methods for improving the function of a client with spasticity (Crepeau, Cohn, & Boyt-Schell, 2003; Pendleton & Schultz-Krohn, 2006; Radomski & Trombly, 2007).

Neurodevelopmental treatment focuses on retraining normal movement while avoiding abnormal (spastic) movement patterns (Bobath, 1990). To avoid abnormal movement patterns associated with spasticity, therapists often spend a significant portion of the treatment session involved in preparatory activities to “normalize” tone before initiation of functional movement. Participants who receive BTA injections arrive in a more normalized state of tone, allowing the practitioner more time to provide appropriate therapeutic intervention. Neurodevelopmental treatment techniques are most effective when they are linked with occupational activities that are functional and meaningful to the patient (Pendleton & Schultz-Krohn, 2006). Aunti-Ramo et al. (2001) investigated this claim and discovered that permanent functional improvements were more likely to occur following BTA injections if they were followed by bilateral activities and therapeutic guidance related to daily activities and normal movement patterns. The occupational therapist is therefore challenged to work in conjunction with the participant to develop meaningful activities that will encourage normal movement patterns while discouraging patterns normally associated with spasticity.

Denervation of the target muscle alone may not be sufficient to change dysfunctional movement patterns in a limb that has beenstatic for a period of time (Aunti-Ramo et al., 2001). When an extremity is not mobilized, changes occur in muscle length and size, new collagen fiber becomes disorganized, ligaments and support structures become weak, and articular cartilage begins to break down. As a result of these changes, available ROM and strength are often diminished. When these conditions exist, the biomechanical approach to treatment should be considered. This approach focuses on biomechanical and physiological principles that relate to movement, ROM, strength, and endurance (Hagedorn, 1997). Therapeutic interventions may include stretching, ROM, strengthening exercises, and splinting (Chin et al., 2005). Thermoplastic splints can be applied to increase ROM or to position selected joints to allow for functional use of the hand. Correct biomechanical alignment, achieved by active movement or appropriate splinting, is essential in maximizing function (Mulligan & Wilmshurst, 2006). Using these methods after BTA injections, in conjunction with functional activities designed to encourage normal movement patterns, may improve ROM and function and provide sensory feedback to the affected limb, thus resulting in permanent tissue changes and enhancing independence with activities of daily living (ADLs; Hoare & Imms, 2004).

A great deal of money and effort are spent each year treating spasticity and the problems associated with it, often with less-than-satisfactory results (Chin et al., 2005). The client in this case study is a prime example. Rehabilitation professionals are constantly seeking more efficacious interventions to combat spasticity and the problems associated with it. Although BTA does not guarantee a full return to function, when used in combination with therapeutic intervention and functional activities, it did provide this client with positive results.

**Client History**

A 63-year-old right-handed female participant with the diagnosis of right hemorrhagic stroke and left hemiplegia with spasticity in the left hand and wrist was referred for occupational therapy 1 day before BTA injection into the flexor wad. She was evaluated before the injections and scheduled for therapy three times a week for 12 weeks following the injections. Her cerebrovascular accident occurred in 1996. Immediately following the cerebrovascular accident, the participant was admitted to inpatient rehabilitation but was discharged after 1 week because of her low arousal level. She then received in-home occupational and physical therapy for
16 weeks. During that time, the participant made remarkable progress and eventually began ambulating for short distances with moderate assistance and a quad cane and performing ADLs with moderate assistance, adaptive equipment, the right upper extremity, or all of these, exclusively (see Table 1). Since 1996, the participant has been in occupational therapy twice for the fabrication of a resting hand splint only. The participant was motivated and had no cognitive impairments. She lives with her husband, who is also her primary caregiver. The participant voiced a hope that the left upper extremity “would work again.”

At the time of this case study, the participant had received no therapy for more than 2 years. As a result, the wrist was positioned at 120° of flexion; the digits were flexed into a fist with an indwelling thumb (see Table 2). Maximal effort was required by the caregiver to clean the hand or place a soft rag in the hand to keep the digits off the palm. No significant active range of motion (AROM) was present. Skin care issues and pain relief were the motivating factors for treatment at this time. Before the injections, the treating neurologist, the occupational therapist, and the participant discussed the desired and likely outcomes of the procedure. For the initial injection series, the neurologist identified target muscles and delivered 100 mg of BTA transdermally to the extrinsic flexors of the left forearm. The dosage was delivered in 15 injections aimed primarily at the flexor carpi ulnaris (4 injections), flexor carpi radialis (4 injections), flexor digitorum superficialis (4 injections), and supinator (3 injections). Occupational therapy began the next day and was scheduled 3 times a week for 6 weeks, then twice a week for 6 weeks. Following one-on-one therapy, the participant was started on a functional home program and received three more rounds of BTA at the same dosage and application sites as the initial series. The rounds of injections were received at 3-month intervals. Rehabilitation and the BTA injections were overseen by the participant’s neurologist.

### Occupational Therapy Evaluation

I saw the participant for a preliminary evaluation to establish a baseline by taking initial measurements before the injections (see Table 2). I also conducted a functional assessment

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**Table 1. Results of Functional Assessment**

<table>
<thead>
<tr>
<th>Task</th>
<th>Before First Injections</th>
<th>After 12 Weeks of Occupational Therapy Intervention</th>
<th>2 Years After Initial Injections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Holding cup</td>
<td>5, using right hand</td>
<td>5, using left hand</td>
<td>5, using left hand</td>
</tr>
<tr>
<td>Self-feeding</td>
<td>5, using right hand</td>
<td>5, finger feeding with left hand</td>
<td>5, finger feeding with left hand</td>
</tr>
<tr>
<td>Cutting meat</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Dressing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Don socks</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Tie shoes</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Fasten buttons and snaps</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Don splint</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Bathing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transfer</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Washing body</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Washing hair</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Washing hand</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Toileting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transfer to bedside commode</td>
<td>5</td>
<td>5</td>
<td>5; rarely uses it</td>
</tr>
<tr>
<td>Transfer to toilet</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Hygiene</td>
<td>2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Home management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light meal preparation</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Laundry</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Light cleaning</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Open jars or packages</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Grasp and release of 6-in. objects with left hand</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

*Note.* Participant was wearing a cock-up splint that holds the wrist at neutral when performing all activities of daily living at the 12-week and 2-year mark, except for bathing tasks. 5 = independent; 4 = supervised; 3 = minimal assistance; 2 = moderate assistance; 1 = maximal assistance; 0 = total assistance or unable.
of ADLs (see Table 1). The neurologist used this evaluation and the participant’s goals to establish the pattern for injection. To achieve optimal results, functional goals should be set for each individual participant, and these goals should serve to guide treatment and used to measure improvement (Autti-Ramo et al., 2001). The participant’s primary goals were to be independent with donning and doffing of a splint and to be able to use the left upper extremity as an assist to complete ADLs.

**Functional and Motor Control Deficits**

This participant’s motor control deficits and functional losses were consistent with commonly reported cases of cerebral vascular accidents (Gillen & Burkhardt, 2004). The participant demonstrated rigid spasticity of the left forearm, wrist, and hand consistent with the definition provided by Lance and Burk (1974): “A motor disorder characterized by velocity-dependent increase in tonic stretch reflexes with exaggerated tendon jerks, resulting from hyperexcitability of the stretch reflex” (p. 332). Specifically, she presented with decreased functional use of the left forearm, wrist, and hand; pain; inability to perform active motion; and skin care issues. She was unable to extend the digits of the left upper extremity actively or passively off of the palm, thus hygiene and skin care were constant issues. Her husband cleaned the hand once a day with extreme effort on his part, and the participant reported pain at Levels 5 to 8, assessed on a common verbal analogue scale ranging from 0 to 10 (Gordon, Greenfield, Marvin,
Hester, & Lauterbach, 1998; see Table 2). The participant also reported constant Level 4 pain at rest.

Previous splinting had had minimal effect on her hand position. At the time of the evaluation, the participant was wearing a hand and forearm splint that positioned her wrist at 60° of flexion with the digits and thumb only slightly off the palm. She was able to remove the splint but was unable to don it independently. Her husband put the splint on in the mornings with extreme effort. The participant would wear the splint for up to 2 hr and then remove it. Her husband would return at lunch to reapply it.

The participant was unable to grasp or release any size object with the left hand and spent most of her day in bed. She could use the bedside commode independently, but hygiene was difficult and often ineffective. She used her right extremity exclusively to pick up a cup and eat previously prepared snacks, answer the phone, and change channels on the television. Other than those activities, the client depended on her husband for assistance with all other tasks (see Table 1).

Treatment Interventions

I performed the initial evaluation 4 days before the initial injections. Tone was assessed using the Modified Ashworth Scale (MAS; Bohannon & Smith, 1987). The MAS is a nominal scale that quantifies the degree of tone using a range of 0 (normal tone) to 4 (limb rigidity). One day after the first series of injections, tone was assessed on the MAS as a 2. I also noted improvements in PROM, but AROM deficits and joint tightness remained because of the prolonged flexed position. As a result, there was no immediate improvement in functional skills. The biomechanical approach was used to facilitate an increase in passive and AROM. The participant was fitted for a resting hand splint that positioned the wrist at 20° of flexion, the digits off the palm in slight flexion, and the thumb out of the plane of the palm. In addition, she was started on an active and passive stretching and ROM program for the wrist and digits. Each joint was passively stretched for three sets of 10, and the participant was directed in AROM for each digit for three sets of 10. After 2 weeks, she was fitted for a cock-up splint that placed her wrist at neutral and allowed her to use the digits for functional tasks. The resting hand splint was adjusted to neutral at the wrist and was worn at night. Because of the decreased level of spasticity, the participant was able to don and doff both splints independently.

With use of the cock-up splint, functional activities were added to the skilled treatment sessions and the daily home program. The daily home program contained active and passive ROM exercises 3 times a day, followed by a minimum of three functional activities such as folding laundry, carrying a tray with two hands, putting groceries away, and washing dishes. The activities were designed on the basis of the neurodevelopmental approach with the participant’s input and were chosen because they encouraged bilateral arm use and facilitated normal movement patterns. The participant performed these tasks in conjunction with daily passive stretching and AROM exercises for 6 weeks.

The participant also was seen for formal occupational therapy sessions 3 times a week for 6 weeks and then twice a week for 6 weeks. During the sessions, the participant received AROM and PROM with a focus on decreasing intrinsic and extrinsic tightness and facilitating function of ADLs. Functional activities and ADLs were also incorporated into the sessions to promote grasp and release within the parameters of normal movement patterns.

At the conclusion of 12 weeks, occupational therapy services discharged the client to continue with the home program. At that time, the participant’s functional skills had significantly improved. She was independent with most of her target ADLs and required only standby assistance for transfers to the tub. Tone decreased to a MAS score of 1, and the participant reported no pain at rest and pain only at Levels 2 to 4 during ROM activities. The participant was compliant with the home program, according to her and her husband’s report, and she continued with the BTA injections at 3-month intervals for three more sessions.

Thirteen months after the last injections, the client was reassessed (see Tables 1 and 2). Following a reevaluation, improvements were noted in areas of AROM, performance of ADLs, and pain. In addition, a patient interview was completed, and the participant reported that she had accomplished all her goals and was pleased with her progress.

Results

After 12 weeks of occupational therapy intervention and compliance with the home program, the participant’s progress was substantial. The combination of spasticity reduction through the use of BTA and improved motor control through splinting; occupation-based activities; and a purposeful, function-based home program contributed to improved occupational performance. In addition to the improvements noted after the initial therapeutic intervention, the client has maintained those improvements for nearly 2 years after direct occupational therapy services and 1 year after the BTA injections (see Tables 1 and 2).

The participant is now independent in all areas of ADLs that were relevant to her, except for bath transfers, which require stand-by assistance (see Table 1). The participant is able to grasp and release a grab bar to enter and exit the
shower, and she is able to hold a wash rag with the left upper extremity. She reported, “I could do it by myself if I had to, but I just like to have someone there.” She is independent with dressing, using the left upper extremity as an assist to independently tie shoes and fasten buttons. She is able to independently don and doff her splints. The client is able to successfully use her left hand as a functional assist; however, she continues to have difficulty with fine motor activities because of a decrease in intrinsic muscle function. At the time of the 2-year reevaluation, the participant reported no pain at rest and only minimal pain during ROM activities (see Table 2). The decrease in pain is attributed to better positioning, a more relaxed state, and decreased tone.

The participant also reported unexpected improvements at discharge and at the 2-year follow-up. As spasticity decreased and ability to use the left upper extremity increased, the participant reported a subjective increase in confidence and ease during ambulation. Mulligan and Wilmshurst (2006) reported that correct biomechanical alignment maximizes function. Therefore, it is reasonable to assume that these improvements may have been a factor in reducing the severe spasticity and its effects on overall trunk control and balance. The participant is now able to use a rolling walker and a quad cane for independent ambulation through the house and on even surfaces. In addition, she reported less apprehension in public situations and increased self-esteem, with greater acceptance of her physical appearance. Per the participant’s subjective reports, she is now going out to dinner at least once a week.

At the time of the final reevaluation 2 years after the first series of injections, the participant is routinely and spontaneously using the left upper extremity to perform gross motor and assistive activities and has had no decline in function. She continues to wear the cock-up splint, but she no longer participates in formal therapy or a structured home program.

This participant’s goals were to increase the ease of caring for the affected upper extremity and to increase its functional use to allow for independence in ADLs. These goals were achieved through BTA injections and a therapeutic program that was both functional and meaningful to the client. Biomechanical and neurodevelopmental approaches, with emphasis on purposeful activity, complemented the BTA and were related to success for this particular client. However, other treatment approaches could also be considered.

Discussion

The literature suggests that BTA can be an effective complement to therapeutic intervention (Koppes, 1997). BTA has the potential to decrease tone and improve PROM, but function-based therapeutic intervention is needed to improve volitional movement (Autti-Ramo et al., 2001). This case report supports that claim. The client in this case report experienced an immediate decrease in tone after the first injections of BTA. However, AROM and functional use of the extremity did not occur until after therapeutic intervention was introduced.

Previous therapeutic intervention had been minimally successful with this client. However, BTA in combination with occupational therapy services contributed to positive outcomes that remained 2 years after her initial evaluation. As suggested by Autti-Ramo et al. (2001), the incorporation of normal movement patterns with daily activities is more likely to produce long-term effects; therefore, the selected interventions were based on the neurodevelopmental and biomechanical models and were meaningful to the client. Correct biomechanical alignment is important for maximum function (Mulligan & Wilmshurst, 2006). Therefore, daily stretches and exercises in combination with splinting were used to encourage appropriate alignment, and functional activities were used to encourage ease of movement. Neurodevelopmental and biomechanical models were used with this client; however, these are not the only models available to therapists. Other models may possibly have yielded similar results. For this reason, it is imperative that the therapist focus on the client’s functional needs and assess improvement on the basis of functional return, not just a decrease in tone (Kuijk et al., 2002). Two years after the initial evaluation, this client had a mild increase in tone and a decrease in AROM in some areas; however, her functional skills remained the same or improved. The measure of improvement for this client rests with the functional improvements, not with the numerical values of the initial evaluation.

This case report is based on one individual; therefore, it may not generalize to other persons. This particular client was cognitively intact and extremely motivated. It is possible that the results would have been less impressive if the client had been cognitively impaired or if she had not participated so actively in the therapeutic process. In addition, this client had not received any formal therapy for more than 10 years; therefore, there is no way to differentiate the effects of the therapeutic interventions from those of the BTA. She may possibly have improved with therapeutic interventions exclusively. As with any case report, it is important to avoid generalizing from this report to other persons. Each client should be evaluated individually and treatment options chosen on the basis of the client’s individual needs.

Conclusion

BTA is a diverse drug, and many occupational therapy arenas provide opportunities for its use. However, it is not a miracle
drug, and failure to provide therapeutic intervention is likely to result in disappointing outcomes. In combination with functional, activity-based interventions, BTA has the potential to facilitate neurological change and provide an opportunity from which functional use of a spastic limb is possible. Functional activities that are performed as part of normal daily activities are an excellent way to expand on the benefits of BTA, especially in participants with long-term spasticity. The occupational therapist, working in conjunction with the neurologist and client, is the logical rehabilitation professional to foster this type of program.

References


