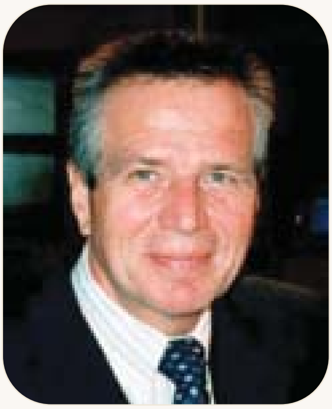
Björn U. Zachrisson
Oslo, Norway

and



Hans-Peter Bantleon
Vienna, Austria

ASK AN EXPERT

THINGS YOU WANT TO KNOW

Q

Optimal mechanics for mandibular molar uprighting

Adult and elderly patients often have molars that are supraerupted and/or mesially tipped. Mesial movement and tipping of mandibular molars after previous extractions may initiate a vicious cycle of traumatic occlusion, functionally disturbing interferences, paralleling dilemmas associated with prosthetic rehabilitation, space problems in conjunction with implant insertion, and periodontal problems. There are several questions of clinical interest related to the orthodontic uprighting and leveling of tipped mandibular molars, such as:

- *Is there any evidence-based information that orthodontic uprighting will prevent the progression and acceleration of destructive periodontitis?*
- *Since tipped molars in some patients may be partly impacted and in other persons extruded above the occlusal plane, will similar tipback methods for molar uprighting frequently have undesirable side effects?*
- *The most common practical problems in adults occur after mesial tipping and overeruption of mandibular second molars following loss of the first molars. In clinical reports, there are different methods proposed to provide simultaneous molar uprighting and intrusion. Which of these techniques should be preferred for such movements?*
- *Is it likely that presently available techniques for molar uprighting can be further improved, for example with the addition of temporary miniscrews?*

—Kurt Faltin, Jr, São Paulo, Brazil

A

Do tipped molars cause or aggravate periodontal tissue breakdown?

The problem of mesially tipped mandibular molars because of nonreplacement of missing first molars (Figs 1a, 2a, 3a, 6a, 7b) has been the subject of many anecdotal reports over the past 30 years. Tipped molars have been considered a causative or at least an aggravating factor for future periodontal tissue breakdown. However, Lundgren et al[1] observed that 73 molars that had remained in a markedly tipped position for at least 10 years, with most molars having been tipped for as long as 20 to 30 years, did not constitute an increased risk for aggravation of moderate periodontal disease at their mesial surface. The study did not consider the potential risk for aggravation of already established advanced periodontitis lesions. This lack of correlation may not exclude other indications for

Fig 1 Typical position of mesially tipped mandibular molar following previous extractions in a female patient, 39 years of age **(a)**. The second molar position was corrected using crossed tip-back springs **(b)** to provide simultaneous uprighting, intrusion, and distal movement. Note that the anterior spring is attaching on the distal side of the molar tube *(arrow in b)*. Subsequently, the premolar was moved distally to build up the alveolar bone for a single implant behind the canine **(c)**.

Fig 2 Panoramic pretreatment view in female patient, 40 years of age, who has lost both mandibular first molars. Both tipped second molars show mesial angular bone loss, particularly on the left side **(a)**. The desired molar movement (distally with simultaneous uprighting and intrusion) was achieved with crossed cantilever springs **(b)**. Note **(c)** how the anterior spring from a vertical slot in the first premolar bracket is attached distal to the mandibular double tube *(arrow)* to provide the intrusive effect.

molar uprighting, such as functionally disturbing interferences, paralleling or space problems associated with prosthetic rehabilitation, or traumatic occlusion.

Also Wehrbein and Diedrich,[2] in histologic-histomorphometric evaluations, found no difference in mesiomarginal bone levels between tipped and upright molars in young adults (20 to 35 years of age). However, they observed a higher amount of supra- and subgingival plaque, more inflammatory cells and capillaries, and a lower density of gingival fibers mesial to the tilted molars. The plaque-induced inflammatory infiltrates on the tipped molars apparently had affected the bone levels on the distal aspect of teeth located mesial to them. Orthodontic uprighting may improve such conditions.

Anatomic or periodontal osseous lesions along the mesial surface of tipped molars?

A mandibular second molar that has tipped mesially because of a missing first molar may appear to have an apparent pocket and angular bone loss along its mesial surface.[3] This may be a sign of adaptation of the bone to the tilted tooth position and represent an anatomic variation. Lines drawn from the adjacent cementoenamel junctions (CEJs) appear to parallel the alveolar crest.[2–4] While uprighting such a tooth appears to cause a shallowing-out of the angular defect, with new bone forming at the mesial alveolar crest, it may merely reflect the inclination of the molar relative to the alveolar bone, and the attachment level remains unchanged. When there is a definite osseous defect caused by periodontitis on the mesial surface of the inclined molar (Figs 2b and 3a), uprighting the tooth and tipping it distally will widen the osseous defect. Any coronal position of bone may be due to the extrusion component of the mechanotherapy.

Fig 3 Pretreatment panoramic view of female patient, 46 years of age, with generalized moderate periodontal breakdown **(a)**. The mandibular right second molar is markedly tipped after previous first molar extraction, and shows evident mesial angular bone defect. The uprighting spring **(b)** has resulted in marked extrusion of the mesial part of the molar crown (compare axial inclinations in a and b). In addition, the patient's oral hygiene is suboptimal, and visible plaque is apparent on the mesial surface of the molar. The unfavorable combination of occlusal interference and poor oral hygiene conditions is manifested in the posttreatment radiographic appearance **(c)**.

Molar uprighting methods—clinical experiences

In 1973, Brown[5] presented data that orthodontic procedures in periodontally compromised patients may consistently produce teeth with favorable axial inclinations, restore a normal occlusal plane, and improve landmark relationships. He used thin sectional archwires to minimize adverse tooth movements, and auxiliaries such as uprighting springs and open coil springs to obtain the desired molar movements. Despite a mesial marginal bone loss of 0.5 to 1 mm, uprighting molars was found to be a therapeutic regimen that may be routinely included in the sequence of therapy of periodontal disease.

Similarly, in a thorough study of periodontal condition around 30 tipped mandibular second molars that were uprighted using box-loop and uprighting spring before prosthetic replacement, Lang[6] reported that after completion of a hygiene phase, significant probing pocket reduction (mean 1.0 mm) was noted on all surfaces. In addition, a further significant reduction in probing depth (mean 0.6 mm), associated with a gain of clinical attachment (mean 0.4 mm), was found on the mesial and lingual aspects of the molars as a result of the orthodontic uprighting. Lang[6] concluded that uprighting of tipped molars is a simple and predictable procedure, provided excellent plaque control is maintained.

In another clinical-radiological study of 21 tipped mandibular molars with no apparent periodontal breakdown, Wehrbein and Diedrich[7] generally used Burstone-type stainless steel or TMA sectional springs to simultaneously intrude and upright the tipped molars. They used a 2-month oral hygiene phase before the orthodontic treatment was begun. Measurements of probing depth, bone level, plaque index, sulcus bleeding index, and tooth mobility demonstrated more favorable periodontal conditions after the uprighting. In some cases, occlusal interferences occurred even though the force system indicated intrusion and uprighting, but the premature contacts were removed by grinding.

Kessler,[3] on the other hand, stated that uprighting of mesially inclined molars is not a panacea, and showed some cases in adult patients in which evident bone loss and furcation involvement developed during the orthodontic uprighting procedure. Due to the furcation involvement and increased mobility, such teeth were no longer considered suitable as abutments, although they were properly uprighted. The iatrogenic development of probing depth and bone loss may be induced by a combination of orthodontic extrusion, chronic inflammation, and occlusal trauma (Fig 3c). Thus, Burch et al[8] found that when a common segmental uprighting spring was used in adults with generalized, moderate periodontitis, the furcation defects in 20 tipped molars remained the same or worsened, associated with the orthodontic uprighting. In 60% of the uprighted molars, there was an increase in distance between the mesial CEJ and the adjacent crestal bone, indicating extrusion and/or mesial bone loss. Those furcations that increased in severity were associated with molar extrusion and possible periodontal inflammation.

Fig 4 The prefabricated Sander spring consists of a short nickel-titanium superelastic posterior segment that is connected by means of a crimpable tube to a stainless steel sectional wire **(a,b)**. The prefabricated two small tubes are soldered together at a 90-degree angle **(c)**. By this means, one tube can be threaded onto the anchorage archwire, and the other provides the vertical tube where the stainless steel sectional wire is to be inserted.

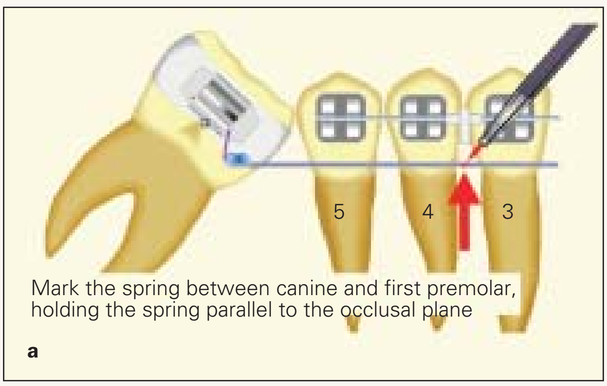
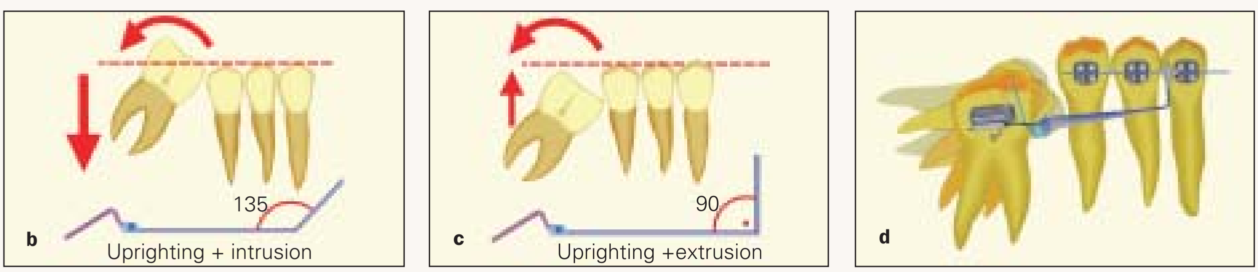


Fig 5 Schematic drawings of the fabrication and activation of the Sander spring. The posterior superelastic segment is inserted in one of the molar tubes, and the stainless steel sectional wire is marked between the canine and first premolar **(a)**. For simultaneous uprighting and intrusion, the bend in the anterior region (alpha position) should be about 135 degrees **(b)**; for uprighting with extrusion, a 90-degree bend is made **(c)**. The mechanism of action is shown **(d)**. The advantage of this spring is that the superelastic part transfers constant moments and forces to the molar, whereas the steel part makes it possible to simply and easily make and adjust the alpha bend.



All simple tip-back–uprighting springs have the side effect of extruding the molar as its axial inclination is improved. This frequently necessitates occlusal adjustment throughout treatment,[8] or the use of a bite-plane,[3] to avoid heavy occlusal interferences. To prevent the extrusion, a counteracting intrusive force is needed. In 1992, Weiland et al[9] reported that this can be achieved simply by using a second tip-back spring. The second spring can be attached in the vertical slot of a bracket in the canine/first premolar area (Figs 1b and 2b), or in a vertical washer soldered to the stabilizing wire in the first premolar region. As long as the two springs are activated equally, the vertical forces will cancel each other out. Tipping the molar without intrusion will result in an extruded position of the molar as it erupts. The molar can be intruded during the uprighting by activating the mesial spring so that it delivers 20 g more force than the distal spring.[9] This generates an extrusive force and moment in the anterior segment that may be countered by a maxillary splint or similar device.

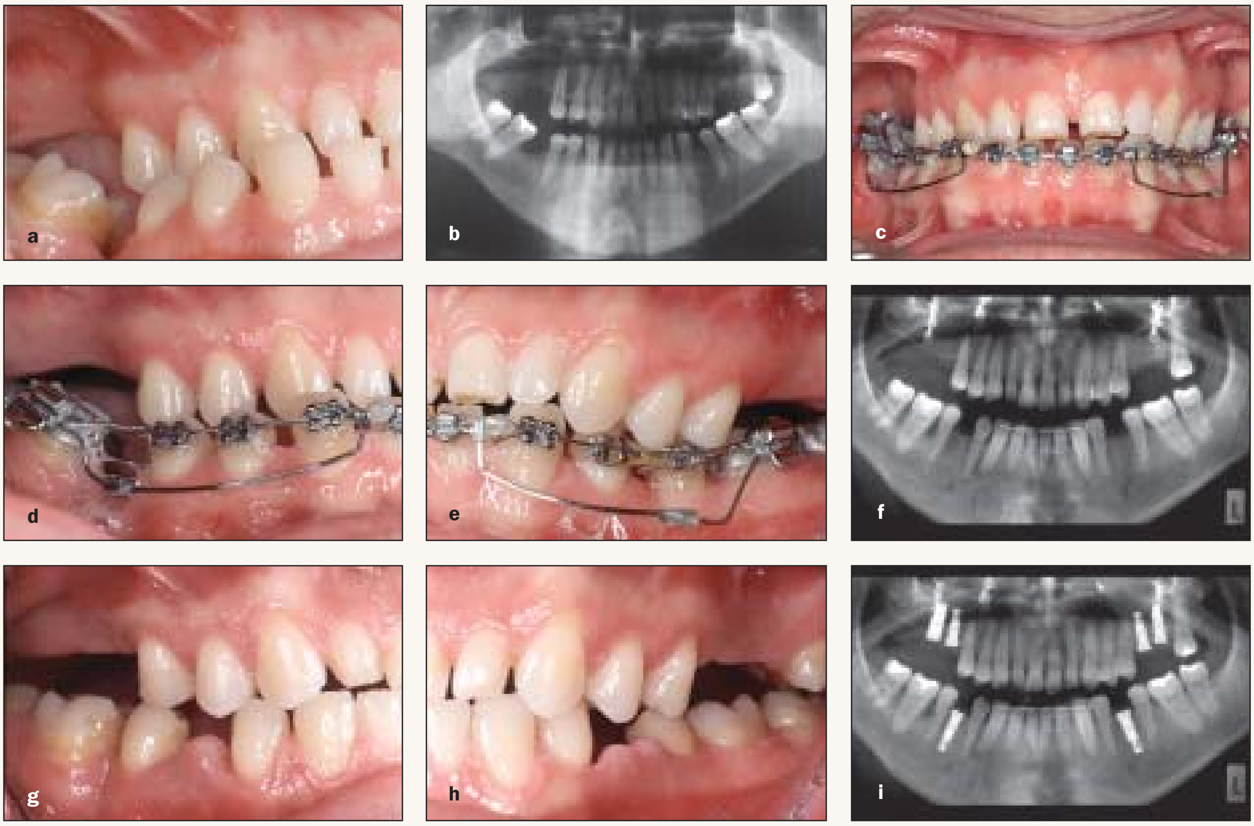


Fig 6 Young adult male patient in whom both mandibular first molars were previously extracted **(a,b)**. The treatment plan included uprighting and intrusion of both second molars by means of Sander springs, with the vertical tube mesial to the canines **(c to e)**. Subsequently, the second premolars were moved distally **(f to h)** for implant site development behind the first premolars **(i)**. Four implants were inserted in the maxillary posterior region, and the maxillary incisors were restored with four porcelain laminate veneers.

Need for differential diagnosis of mesially tipped molars

Melsen et al[10] remarked that simple appliances for molar uprighting do not take individual patient variations into account. Mesially inclined molars should be differentiated by the types of tooth movement required for correction in all three planes of space.[10] For any particular tooth movement, there is only one correct force system with respect to the center of resistance (CR). Therefore, a differential diagnosis is important before selecting the optimal force system and appliance design.

In the sagittal plane, the appropriate combination of vertical movement and uprighting must be determined. Mandibular molar extrusion may be desirable in some early orthodontic treatments when the tipped molar is below the functional occlusal plane (FOP), for example when the mandibular second molar has been impacted following sagittal expansion or lip-bumper therapy.[10] Simple tip-back mechanics can then be used. The applied force can be measured with a force gauge. The moments should be about 2,000 gmm, but not more than 3,000 gmm.[9,11] If significant extrusion is needed, the force delivered at the anterior stabilizing segment should be large. If little extrusion is desired, the force should be lower, and the anterior arm of the cantilever spring should be made as long as possible.[10]

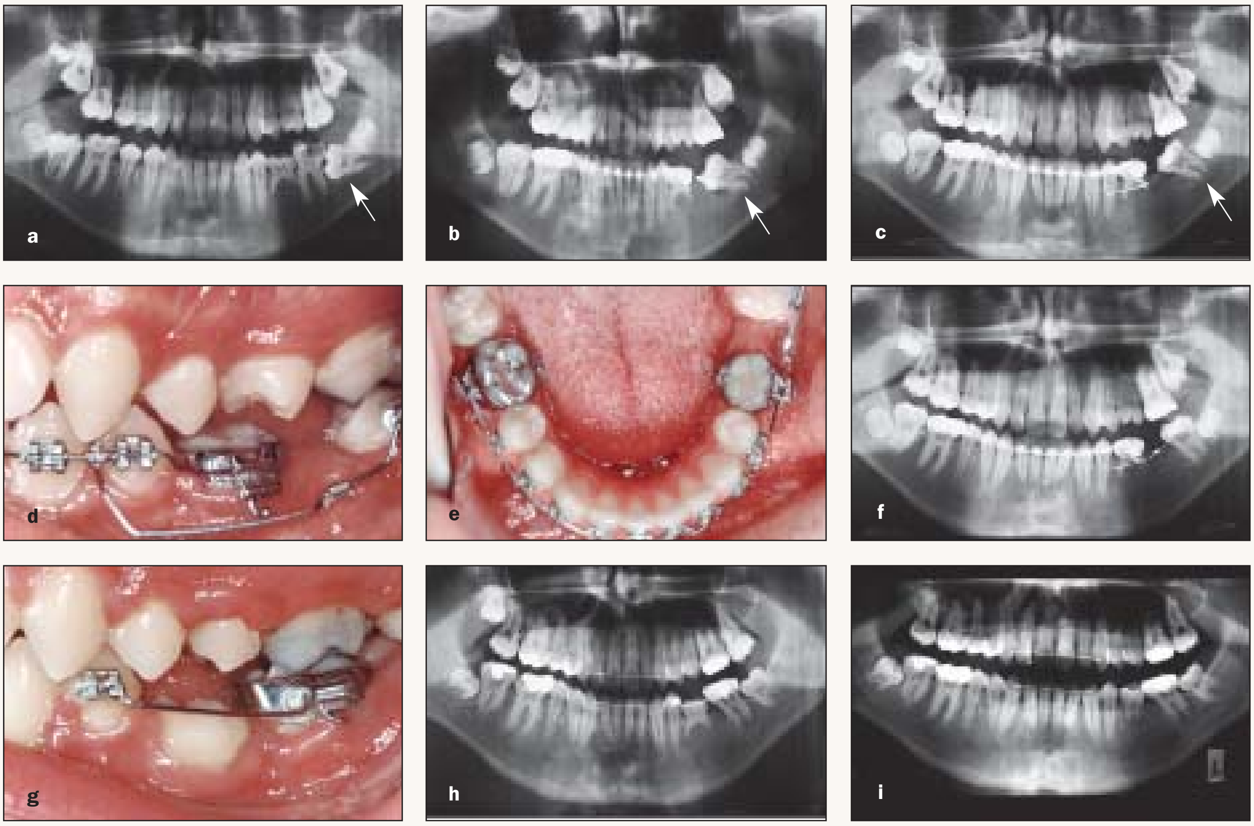


Fig 7 Use of Sander spring to upright and intrude an almost horizontal mandibular left second molar *(arrows in a to c)* in young boy, 13.5 years of age at the start of treatment **(a)**. The carious mandibular first molar was extracted, and the second molar was moved mesially with bonded chain, against the ankylosed primary molar **(b)**. Next, the second molar was uprighted and intruded using the Sander spring with the vertical tube between the canine and first premolar **(c to f)**, and moved mesially **(g)**. At the end of treatment **(g,h)**, the developing maxillary right third molar was autotransplanted to replace the ankylosed primary molar in the third quadrant **(i)**.

Whenever the distal portion of the tipped molar crown is above the FOP, molar intrusion is required (Figs 1 to 3, 6, 7), and the biomechanics become more complex. The law of equilibrium requires that the moment added to the molar should be smaller than the moment added to the anterior unit.[9,11,12] This can be obtained by proper activation of a Burstone root spring as described by Roberts et al,[11] by using a non-centered V bend,[12] or more conveniently and safely by using two crossed cantilever springs.[9,10] One cantilever is then used for the molar uprighting, with the extrusion component of the molar reduced or eliminated by another cantilever spring coming from a vertical tube in the anterior segment or from a vertical slot in an anterior bracket and attaching somewhere on the distal aspect of the molar (Figs 1b, 2b, 2c). With two cantilevers, the force system is more constant and easier to monitor than with V bends.[9,10]

Although molar uprighting with the use of two crossed tip-back springs (Figs 1c, 2b, 2c) can provide successful clinical results,[9,10] a drawback with this technique is that the two springs may be uncomfortable for the patient, as the spring arms may impinge into the cheek mucosa. Even if plastic tubing is used to cover the spring wire (Fig 1b), the authors' experience indicates that this technique may be inconvenient for the patient. For this reason, the simpler and neater Sander spring[14] (Figs 6c to 6e, 7d, 7e) is preferred.

The optimal molar uprighting technique

As mentioned, the most appropriate method for molar uprighting must be determined in each particular case. It should be understood, however, that clinical problems that have been associated with molar uprighting in adults[3,5,8] are largely caused by the extrusive component of the coronal tip-back method of the orthodontic technique, particularly in combination with insufficient oral hygiene measures (Fig 3c). When force systems that yield molar intrusion have been used, occlusal trauma can be avoided, and unwanted harmful side-effects are not apparent.[7,13–15] Small radiolucent areas between the molar roots at the end of orthodontic uprighting, when extrusive movement has been avoided, may reflect immature bone.

The optimal molar-uprighting technique for most situations in adults (Figs 1 to 3, 6, 7) should thus apply an intrusive force to the molar crown, within an inflammatory-free environment. A safe and simple method to achieve such conditions is to use the prefabricated superelastic Sander spring[14] (Memory-Titanol-Feder no. 307-1012; Forestadent, Bernard Förster GmbH, Pforzheim, Germany) (Fig 5). The posterior component (beta position[11]) of this spring consists of a 0.016 × 0.022-inch superelastic wire that is attached by a crimpable tube to a straight piece of 0.017 × 0.025-inch stainless steel sectional wire (Fig 4b). The anterior portion (alpha position[11]) is inserted in a prefabricated crimpable vertical cross tube (Kreuzrörchen 0.022 inch, no. 760-0063; Forestadent) (Figs 4c, 5d), generally located between the first premolar and canine (Figs 5d, 7d) (or in a canine bracket vertical slot). For molar uprighting and simultaneous intrusion, the anterior angle should be 135 degrees (Fig 5b); for molar uprighting and extrusion, the bend should be 90 degrees (Fig 5c). Further details can be found on www.uni-ulm.de/klinik/zmk4.

Figures 6 and 7 show two different cases where the second molars have been successfully uprighted and intruded by means of the Sander spring.

Can miniscrews be used to further improve current molar uprighting techniques?

There are reasons to believe that in future applications, the use of temporary anchorage devices such as different types of bone miniscrews (Abso-Anchor, Spider screw, Aarhus anchorage system, Tomas screw, etc) may aid in achieving the most desirable tooth movements for molar uprighting in adults. For example, insertion of a bone screw in an apical location either distally or mesially to a tipped mandibular molar and application of a force from the screw to the distal end of the archwire protruding from the molar tube would constitute an exciting predictable mechanism to get the desirable molar intrusion. Such temporary bone screws can also be used to avoid unwanted distal movement and/or assist in mesial movement of mandibular molars.

Conclusion

The appropriate method for molar uprighting must be determined in each particular case. Reported clinical problems in adults (furcation involvement, mesial marginal bone loss, increased tooth mobility) are generally due to the extrusive component of simple tip-back methods and inadequate oral hygiene measures. Whenever a part of the tipped molar crown is above the FOP, the optimal technique should apply an intrusive force to the molar as its axial inclination is being improved, in an inflammation-free environment. The prefabricated Sander spring is a simple, safe, and effective method for mandibular molar uprighting (Figs 6 and 7). Future applications may include temporary miniscrews for improved molar intrusion.

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Send it to: T. M. Graber, Editor-in-Chief
University of Illinois at Chicago,
College of Dentistry
801 South Paulina, M/C 842
Chicago, Illinois 60612, USA

or E-mail to: tgraber@uic.edu