The optimum treatment of Type II odontoid fractures in the elderly remains controversial. Coexisting medical conditions encountered in the elderly patient often increase operative risk and make cervical immobilization difficult to tolerate. Previous studies have shown increased morbidity and mortality and decreased fusion rates for Type II odontoid fractures treated with cervical orthoses in the geriatric population, whereas low morbidity and mortality rates with operative management have recently been documented. To investigate the role of surgical and nonsurgical treatment, a retrospective analysis was performed of patients with Type II odontoid fractures who were at least 65 years old and were consecutively admitted to a single medical center from 1994 to 1998. Twenty patients met inclusion criteria. In 12 patients nonsurgical management with a cervical orthosis was attempted. The nonsurgical management failed early in six patients, with one associated death. Eleven patients were treated surgically with either anterior odontoid screw fixation or posterior C1–2 transarticular screw fixation and modified Gallie fusion. Postoperatively one patient required revision of the C1–2 transarticular screws, and there was one death. In conclusion Type II odontoid fractures in this elderly population were associated with early 10% morbidity and 20% mortality rates. Nonsurgical management of Type II odontoid fractures failed early in six (50%) of 12 patients, whereas surgical treatment failed early in one of 11 (9%) patients. Both the nonsurgical and surgical treatments resulted in approximately 10% morbidity and 10% mortality rates.

Key Words • odontoid • fracture • geriatric • surgical management • nonsurgical management

CLINICAL MATERIAL AND METHODS

A retrospective review was performed of the records of patients aged 65 years or older who were consecutively admitted to a single medical center (regional level 1 trauma center) with a diagnosis of C-2 fracture between 1994 and 1998. Thirty-six patients aged 65 years or older were consecutively admitted with a diagnosis of C-2 fracture during the years of the study. Odontoid fractures were classified according to the method of Anderson and D’Alonzo.1 Of the 36 patients, 20 had Type II odontoid fractures. There were 12 men and eight women, ranging in age from 66 to 92 years (mean 80 years). These 20 patients represent approximately 4% of all patients admitted to Harborview Medical Center for management of cervical spine fractures during the years of the study. Odontoid fractures were treated surgically with either anterior odontoid screw fixation or posterior C1–2 transarticular screw fixation and modified Gallie fusion. Postoperatively one patient required revision of the C1–2 transarticular screws, and there was one death. In conclusion Type II odontoid fractures in this elderly population were associated with early 10% morbidity and 20% mortality rates. Nonsurgical management of Type II odontoid fractures failed early in six (50%) of 12 patients, whereas surgical treatment failed early in one of 11 (9%) patients. Both the nonsurgical and surgical treatments resulted in approximately 10% morbidity and 10% mortality rates.

Key Words • odontoid • fracture • geriatric • surgical management • nonsurgical management

The optimum treatment of Type II odontoid fractures in the elderly remains controversial.7,10–12 The medical frailty of the geriatric patient often compromises treatment, increasing the risks of both nonsurgical management with a cervical orthosis and surgical treatment with internal fixation and fusion. Surgical and nonsurgical treatment of odontoid fractures in the elderly is associated with higher morbidity and mortality rates when compared with younger patients with similar injuries.7,10,11 Authors of recent investigations have reported that prolonged cervical immobilization in a halo-thoracic vest is often not well tolerated by the geriatric patient, leading to increased morbidity and mortality rates and a high rate of nonunion, while authors of contemporary reports of surgically treated Type II odontoid fractures in the elderly have found acceptably low morbidity and mortality rates with a high rate of union.4,7,11 To further investigate the role of surgical and nonsurgical treatment of Type II odontoid fractures in the elderly, we retrospectively reviewed the records of all patients aged 65 years or older in whom a diagnosis of Type II odontoid fracture had been made and who were admitted to Harborview Medical Center between 1994 and 1998.

Abbreviation used in this manuscript: SCI = spinal cord injury.
family was contacted regarding long-term outcome. Fusion was defined as evidence of bone healing at the odonto-
toid fracture site or posterior C1–2 bone graft fusion site and, when available, absence of movement on flexion–
extension radiographs. Early failure of treatment was de-
dined as inadequate immobilization of the fracture within
the first 30 days of treatment; inability of the patient to tol-
erate the treatment resulting in a change of the treatment plan, or death of the patient within 30 days of the treat-
ment.

RESULTS
Patient Population
The mechanism of injury was a fall in 15 patients, a
motor vehicle accident in three patients, bicycle accident
in one patient, and one patient was struck by an auto-
mobile. Four patients had associated spine fractures at
other segmental levels, and nine patients had associated
nonspinal injuries. The number of days in the hospital
ranged from 1 to 24 days, with a mean of 12.5 days. The
surgical and nonsurgical groups were similar with respect
to age, sex, mechanism of injury, type of spine fracture,
SCI, associated nonspinal injuries, and follow-up period
(Tables 1 and 2).

Evaluation of initial radiological studies revealed that at
the time of diagnosis the odontoid displacement ranged
from 0 to 11 mm, with a mean displacement of 5.4 mm.
In the nonsurgical group the mean odontoid displacement
was 4.5 mm, whereas in the surgical group the mean
odontoid displacement was 6.6 mm. The odontoid frag-
ment was anteriorly displaced in three patients and poste-
rionally displaced in 16 patients. Spinal cord injury was pre-
ent in three patients and was always associated with
posterior displacement of the odontoid.

Management Protocol
All patients were evaluated at Harborview Medical
Center. When an odontoid fracture was suspected or diag-
nosed, the neurological and orthopedic surgical teams
were consulted. Patients with suspected or diagnosed
odontoid fractures underwent high-resolution comput-
erized tomography scanning from the occiput to C-3. Mag-
netic resonance imaging was performed in all patients
with suspected or diagnosed SCIs. After the diagnosis of
odontoid fracture was made, the patient either underwent
cervical traction for realignment of the odontoid or a cer-
vical orthosis was determined on serial cervical radio-
graphs by the senior treating surgeon over a period of time
ranging from 6 to 28 days after the injury.

RESULTS OF PATIENT FOLLOW-UP REVIEW
Outcome analysis revealed that four patients died dur-
ing the initial hospitalization. Two patients died after ad-
mission to the hospital, secondary to injuries unrelated to
the odontoid fracture: a 91-year-old woman with severe
dementia and a closed head injury died soon after admis-
sion when support was withdrawn and an 81-year-old man
treated in a Minerva brace died of a significant closed
head injury 6 days after the injury. The two remaining
deaths occurred during treatment of the Type II odontoid
fracture (one in the nonsurgical group and one in the sur-
gical group): an 86-year-old man treated in a Minerva
brace developed pneumonia and died after a respiratory
arrest and an 84-year-old man died of cardiopulmonary
failure postoperatively. Of the 16 patients discharged from
the hospital, follow-up data were available for 15 patients
with a mean follow-up time of 14 months. For one patient
discharged from the hospital who was doing well, there
was no information after the initial hospitalization.

Nonsurgical Treatment
Nonsurgical management was used in 14 of the 20 pa-
tients (Table 1). The mean age in the nonsurgical group
was 81 years, of whom 57% were men. The mechanism of
injury was a fall in nine patients and associated spinal
fractures were present at other segmental levels in three
patients. One patient had an SCI, and seven patients had
associated nonspinal injuries. The mean hospitalization
time was 13 days for patients who were initially managed
nonsurgically. The average follow-up time in the nonsur-
gical group was 13 months.

After admission to the hospital two patients died of
injuries unrelated to the odontoid fracture or treatment of
the odontoid fracture; these two patients have been
excluded from the further analysis of nonsurgical man-
agement. Of the remaining 12 patients, eight were treated
with a halo-thoracic vest, two were treated with a Minerva
brace, and two were treated with a Miami J collar. The
type of cervical orthosis was chosen based on the anatomy
of the fracture combined with the medical frailty of the
patient. Nondisplaced nondistracted Type II fractures in
medically frail patients were more likely to be treated with
a Miami J collar, whereas displaced distracted Type II
fractures in medically healthy patients were more likely
to be treated with a Minerva brace or halo-thoracic vest.

The nonsurgical treatment failed early in six patients
and was associated with a complication in one patient.
The nonsurgical early failures included: an 86-year-old
man treated with a Minerva brace who developed pneu-
monia and died after a respiratory arrest; a 92-year-old
woman treated with a halo-thoracic vest who developed
failure to thrive (unable to ambulate in the halo-thoracic
vest, she became depressed and refused to eat) and subse-
sequently underwent a posterior fixation and fusion with

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removal of the halo-thoracic vest postoperatively; and four patients (three treated with a halo-thoracic vest and one treated with a Minerva brace) who had inadequate stabilization of the fracture in the cervical orthosis and required surgical intervention (Fig. 1). The average odontoid movement/dynamic displacement in the halo-thoracic vest or Minerva brace for the four patients with inadequate stabilization of the fracture was 6.3 mm. The nonsurgical complication was a pin site infection with loosening of the halo ring requiring antibiotics and adjustment of the pins.

Of the 12 patients in whom nonsurgical treatment with a cervical orthosis was attempted, six patients were discharged from the hospital in the cervical orthosis and completed the course of treatment in the cervical orthosis. Of those six patients, all returned to routine activity with no late neurological deterioration. Radiological evaluation revealed that three of the six patients developed a stable bone fusion, one patient developed a stable nonunion, and one patient with dementia treated with a Miami J collar was stable at 2-month follow up (in one patient there was insufficient follow-up radiographic data). The mean initial odontoid displacement in patients who completed a course of treatment in a cervical orthosis was 3.3 mm, whereas the mean initial odontoid displacement in patients in whom the cervical orthosis failed early was 5 mm. Age, mechanism of injury, type of spine fracture, and associated nonspinal injuries were similar among those patients in whom nonsurgical treatment failed and those patients who completed a course of nonsurgical treatment in a cervical orthosis.

### Operative Treatment

Operative stabilization was performed in 11 of the 20 patients (Table 2). The mean age in the surgical group was 76 years, with 73% being men. The mechanism of injury was a fall in nine patients, and associated spinal fractures were present at other segmental levels in two patients. Three patients had SCIs, and four patients had associated nonspinal injuries. The mean hospitalization time was 14 days, and the mean operation time was 120 minutes. The mean follow-up period was 36 months, and the mean follow-up for patients who completed a course of treatment was 24 months. The mean initial odontoid displacement in patients who completed a course of treatment in a cervical orthosis was 3.3 mm, whereas the mean initial odontoid displacement in patients in whom the cervical orthosis failed early was 5 mm. Age, mechanism of injury, type of spine fracture, and associated nonspinal injuries were similar among those patients in whom nonsurgical treatment failed and those patients who completed a course of nonsurgical treatment in a cervical orthosis.

### Table 1

**Characteristics of patients who were managed nonsurgically**

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Mechanism of Injury</th>
<th>Type of Fx</th>
<th>Odontoid Displacement (mm)</th>
<th>SCI</th>
<th>Associated Injuries</th>
<th>Treatment</th>
<th>Hospitalization (days)</th>
<th>Follow Up (mos)</th>
<th>Radiological Outcome</th>
<th>Clinical Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>83, F</td>
<td>fall</td>
<td>II</td>
<td>0</td>
<td>no</td>
<td>minor CHI</td>
<td>Miami J</td>
<td>3</td>
<td>5</td>
<td>stable fusion</td>
<td>routine activity</td>
</tr>
<tr>
<td>2</td>
<td>89, F</td>
<td>fall</td>
<td>II</td>
<td>2 ant</td>
<td>no</td>
<td>CVA</td>
<td>halo</td>
<td>12</td>
<td>4</td>
<td>stable fusion</td>
<td>routine activity</td>
</tr>
<tr>
<td>3</td>
<td>81, M</td>
<td>fall</td>
<td>II</td>
<td>3 post</td>
<td>no</td>
<td>major CHI</td>
<td>Minerva</td>
<td>7</td>
<td>NA</td>
<td>death 7 days after CHI</td>
<td>activity</td>
</tr>
<tr>
<td>4</td>
<td>87, F</td>
<td>fall</td>
<td>II</td>
<td>8 post</td>
<td>no</td>
<td>minor CHI, radius &amp; metacarpal fx</td>
<td>none</td>
<td>12</td>
<td>2</td>
<td>inadequate stabilization, failed Minerva</td>
<td>NA</td>
</tr>
<tr>
<td>5</td>
<td>81, M</td>
<td>fall</td>
<td>II</td>
<td>1 post</td>
<td>no</td>
<td>minor CHI, radius &amp; metacarpal fx</td>
<td>none</td>
<td>12</td>
<td>12</td>
<td>inadequate stabilization, failed Minerva</td>
<td>NA</td>
</tr>
<tr>
<td>6</td>
<td>92, F</td>
<td>fall</td>
<td>II</td>
<td>5 post</td>
<td>no</td>
<td>none</td>
<td>halo</td>
<td>24</td>
<td>6</td>
<td>adequate stabilization</td>
<td>failure to thrive, failed halo</td>
</tr>
<tr>
<td>10</td>
<td>66, M</td>
<td>fall</td>
<td>II</td>
<td>2 post</td>
<td>no</td>
<td>scalp laceration</td>
<td>halo</td>
<td>13</td>
<td>22</td>
<td>inadequate stabilization, failed halo</td>
<td>routine activity</td>
</tr>
<tr>
<td>12</td>
<td>79, M</td>
<td>bicycle accident</td>
<td>MVA</td>
<td>5 post</td>
<td>no</td>
<td>none</td>
<td>halo</td>
<td>9</td>
<td>5</td>
<td>inadequate stabilization, failed halo</td>
<td>routine activity</td>
</tr>
<tr>
<td>13</td>
<td>71, M</td>
<td>pedestriran struck by car</td>
<td>MVA</td>
<td>10 post</td>
<td>none</td>
<td>none</td>
<td>halo</td>
<td>16</td>
<td>32</td>
<td>inadequate stabilization, failed halo</td>
<td>NA</td>
</tr>
<tr>
<td>14</td>
<td>76, F</td>
<td>II</td>
<td>II</td>
<td>3 post</td>
<td>no</td>
<td>minor CHI, pelvic, tibia, fibula &amp; ankle fx</td>
<td>none</td>
<td>13</td>
<td>24</td>
<td>routine activity</td>
<td>death from pneumonia/respiratory arrest 10 days after injury</td>
</tr>
<tr>
<td>15</td>
<td>86, M</td>
<td>MVA</td>
<td>II &amp; C-1</td>
<td>2 ant</td>
<td>no</td>
<td>none</td>
<td>Minerva</td>
<td>10</td>
<td>NA</td>
<td>nonunion, stable</td>
<td>routine activity</td>
</tr>
<tr>
<td>16</td>
<td>80, M</td>
<td>fall</td>
<td>II</td>
<td>2 post</td>
<td>no</td>
<td>none</td>
<td>halo &amp; Miami J</td>
<td>8</td>
<td>3</td>
<td>nonunion, stable</td>
<td>routine activity</td>
</tr>
<tr>
<td>18</td>
<td>91, F</td>
<td>fall</td>
<td>II</td>
<td>10 post</td>
<td>no</td>
<td>major CHI</td>
<td>Miami J support withdrawn</td>
<td>1</td>
<td>NA</td>
<td>death 1 day after injury</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>70, M</td>
<td>MVA</td>
<td>II, C-1, C6–7, laminae, T-5 comp</td>
<td>10 post</td>
<td>no</td>
<td>none</td>
<td>halo</td>
<td>24</td>
<td>30</td>
<td>inadequate stabilization, failed halo</td>
<td>NA</td>
</tr>
</tbody>
</table>

* Ant = anterior; cent cord synd = central cord syndrome; CHI = closed head injury; comp = compound; CVA = cerebrovascular accident; fx = fracture; GI = gastrointestinal; MVA = motor vehicle accident; NA = not available; post = posterior.
days for patients who were initially treated surgically. The average follow-up period in the surgical group was 17 months.

Surgical treatment consisted of posterior C1–2 transarticular screw fixation with a modified Gallie fusion in nine patients and anterior odontoid screw fixation in two patients. The patients treated primarily with surgery and those treated surgically after failure of nonsurgical treatment were similar with respect to age, sex, mechanism of injury, type of spine fracture, SCI, associated nonspinal injuries, and follow-up period. The mean initial odontoid displacement in patients primarily treated with surgery was 7.5 mm, whereas the mean initial odontoid displacement in patients in whom nonsurgical treatment failed and who required surgical intervention was 5.6 mm.

Surgical treatment failed early in one patient and was associated with a complication in one patient. The surgical early failure occurred in an 84-year-old man who died of cardiopulmonary failure in the early postoperative period. The complication occurred in a 66-year-old man with an associated C-1 fracture and SCI who required revision of the posterior C1–2 transarticular screw fixation and placement in a halo-thoracic brace postoperatively.

Of the nine patients treated with posterior C1–2 transarticular screw fixation, eight were managed postoperatively with either a Philadelphia collar or a Miami J collar for an average of 4 to 6 weeks. Halo-thoracic vest immobilization had failed in both patients treated with anterior odontoid screw fixation because of excessive movement at the fracture site; postoperatively both patients were maintained in the halo-thoracic vest because of poor odontoid screw fixation in osteoporotic bone. The anterior odontoid screw succeeded in providing internal fixation and prevented further odon-

TABLE 2
Characteristics of patients who underwent surgery as a primary or secondary treatment*

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Mechanism of Injury</th>
<th>Type of Fx</th>
<th>Odontoid Displacement (mm)</th>
<th>SCI</th>
<th>Associated Injuries</th>
<th>Treatment</th>
<th>Hospitalization (days)</th>
<th>Follow Up (mos)</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>84, M</td>
<td>fall</td>
<td>II</td>
<td>5 post</td>
<td>no</td>
<td>none</td>
<td>trans screws w/ modified Gallie/Philadelphia</td>
<td>5</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>8</td>
<td>74, M</td>
<td>fall</td>
<td>II</td>
<td>9 post</td>
<td>no</td>
<td>scalp laceration</td>
<td>trans screws w/ modified Gallie/ Miami J</td>
<td>13</td>
<td>36</td>
<td>stable fusion</td>
</tr>
<tr>
<td>9</td>
<td>66, M</td>
<td>fall, C-1</td>
<td>II</td>
<td>7 post</td>
<td>Frankel D</td>
<td>none</td>
<td>trans screws w/ modified Gallie/ Miami J</td>
<td>19</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>11</td>
<td>71, M</td>
<td>fall</td>
<td>II</td>
<td>2 post</td>
<td>Frankel A</td>
<td>none</td>
<td>trans screws w/ modified Gallie/ Philadelphia</td>
<td>18</td>
<td>3</td>
<td>stable fusion</td>
</tr>
<tr>
<td>17</td>
<td>86, F</td>
<td>fall</td>
<td>II</td>
<td>11 post</td>
<td>no</td>
<td>none</td>
<td>trans screws w/ modified Gallie/ Miami J</td>
<td>18</td>
<td>6</td>
<td>stable fusion</td>
</tr>
<tr>
<td>19</td>
<td>79, F</td>
<td>fall</td>
<td>II</td>
<td>11 post</td>
<td>no</td>
<td>ankle fx</td>
<td>trans screws w/ modified Gallie/ Miami J</td>
<td>12</td>
<td>20</td>
<td>stable fusion</td>
</tr>
</tbody>
</table>

Primary operative management

Secondary operative management

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Mechanism of Injury</th>
<th>Type of Fx</th>
<th>Odontoid Displacement (mm)</th>
<th>SCI</th>
<th>Associated Injuries</th>
<th>Treatment</th>
<th>Hospitalization (days)</th>
<th>Follow Up (mos)</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>81, M</td>
<td>fall</td>
<td>II</td>
<td>1 post</td>
<td>no</td>
<td>minor CHL, radius and metacarpal fx</td>
<td>odontoid screw/ halo</td>
<td>13</td>
<td>12</td>
<td>stable fusion</td>
</tr>
<tr>
<td>6</td>
<td>92, F</td>
<td>fall</td>
<td>II</td>
<td>5 ant</td>
<td>no</td>
<td>none</td>
<td>trans screws w/ modified Gallie/ Miami J</td>
<td>24</td>
<td>6</td>
<td>stable fusion</td>
</tr>
<tr>
<td>10</td>
<td>66, M</td>
<td>fall</td>
<td>II</td>
<td>2 post</td>
<td>no</td>
<td>scalp laceration</td>
<td>trans screws w/ modified Gallie/ halo</td>
<td>13</td>
<td>22</td>
<td>stable fusion</td>
</tr>
<tr>
<td>13</td>
<td>71, M</td>
<td>MVA</td>
<td>II</td>
<td>10 post</td>
<td>cent cord synd</td>
<td>no</td>
<td>trans screws w/ modified Gallie/ Miami J</td>
<td>16</td>
<td>32</td>
<td>NA</td>
</tr>
<tr>
<td>20</td>
<td>70, M</td>
<td>MVA</td>
<td>II, C-1, C6–7 laminae, T-5 comp</td>
<td>10 post</td>
<td>no</td>
<td>none</td>
<td>trans screws w/ Gallie BG (no wiring)/ Minerva</td>
<td>24</td>
<td>30</td>
<td>stable fusion</td>
</tr>
</tbody>
</table>

* trans = transarticular.
toid movement at the fracture site but did not obviate the need for postoperative halo-thoracic vest immobilization.

Of the 10 patients discharged from the hospital after surgical treatment, eight returned to routine activity with no late neurological deterioration; one patient was doing well at the time of discharge but there was no long-term follow-up data available; and one patient remained a Frankel Grade A ventilator-dependent quadriplegic at 3-month follow-up examination. A stable bone fusion was achieved in all eight patients with available radiological follow-up data.

**DISCUSSION**

Treatment of odontoid fractures in the elderly can be difficult and is often associated with significant morbidity and mortality rates. Pepin, et al., reported on 41 patients with odontoid fractures, 19 of whom were aged 60 years or older. Halo-thoracic vest immobilization was attempted in four patients older than 60 years; in three the halo-thoracic vest failed, leading to death in one patient and requiring removal of the orthosis in the other two. The authors concluded that a more conservative approach would be beneficial in the elderly. Hanigan, et al., reported on 19 patients aged 80 years or older with odontoid fractures. Five (26%) of the 19 patients died during hospitalization. All five deaths were associated with bed rest and nonsurgical management in a cervical collar. Of two patients treated in a halo-thoracic vest one required removal of the halo secondary to respiratory compromise. None of the five patients surgically treated died, and there was no evidence of late neurological deterioration in patients who developed a stable nonunion. The authors concluded that prolonged bed rest and rigid immobilization were associated with significant morbidity and mortality rates, whereas treatment in a Philadelphia collar with formation of a stable fibrous union may be sufficient in the elderly.

Ryan, et al., reported on 30 patients aged 60 years or older with Type II odontoid fractures. Only one patient underwent primary spinal fusion with the remaining treatments ranging from nothing to a halocast. In this geriatric population there was a 77% nonunion rate but no evidence of late neurological deterioration on follow-up evaluation. Bednar, et al., reported a 46% in-hospital mortality rate in 33 consecutive elderly patients with Type II odontoid fractures who were managed nonsurgically and no in-hospital deaths in 11 consecutive patients who were treated surgically. The authors concluded that an aggressive primary surgical management protocol can significantly decrease in-hospital mortality. The authors of three recent series on surgically treated elderly patients with odontoid fractures have reported surgical mortality rates from 0 to 57%. The current study represents a retrospective review of patients aged 65 years or older with Type II odontoid fractures who were consecutively admitted to a single medical center over a 5-year period. Consistent with previous investigations, low-energy falls accounted for the majority of the fractures, posterior displacement of the odontoid predominated, SCI was associated with posterior displacement of the odontoid, and associated in-hospital deaths were high at 20%. Initial treatment was chosen based on the anatomy of the fracture and the medical frailty of the patient, combined with the wishes of the patient and family. The mean initial odontoid displacement was greatest (7.5 mm) in those patients treated primarily with surgery and least in those patients who completed a course of treatment in a cervical orthosis (3.3 mm).
In 14 (70%) of 20 patients the primary treatment was nonsurgical. The nonsurgical treatment consisted of an external cervical orthosis, which was a halo-thoracic vest, Minerva brace, or Miami J collar. The goal of treatment with the cervical orthosis was stabilization of the odontoid fracture and early mobilization of the patient. Of the 12 patients treated in a cervical orthosis six were treatment failures. All of the treatment failures and complications were in patients treated in either a halo-thoracic vest or Minerva brace. Treatment failed in six of 10 patients treated with either a halo-thoracic vest or Minerva brace. The failure of these cervical orthoses in which a thoracic vest was used was secondary to either restricted mobility producing respiratory compromise and failure to thrive or inadequate stabilization of the fracture. Lind, et al.,8 published data suggesting that there might be decreased ventilatory capacity in patients wearing halo-thoracic orthoses, and Anderson, et al.,2 documented movement of the cervical spine in the halo-thoracic vest after cervical spine injury. A possible explanation for the high failure rate of cervical orthoses in which a thoracic vest is used in the elderly is that the decreased respiratory reserve in the geriatric population is significantly further compromised by the thoracic vest, leading to morbidity and death. The decreased respiratory reserve in the elderly may also limit a tight fit between the vest and the thorax, resulting in inadequate external immobilization. A true evaluation of the less restrictive Miami J collar is not possible in this study because of the small number of patients treated with this cervical orthosis.

The goal of surgical treatment of Type II odontoid fractures is internal fixation and ultimately fusion of the fracture or bone graft. Although both anterior odontoid screw fixation and posterior C1–2 transarticular screw fixation with modified Gallie fusion achieved these goals in this population, the two patients treated with anterior odontoid screws were maintained in a halo-thoracic vest postoperatively because of poor odontoid screw fixation in osteoporotic bone. Because halo-thoracic vest immobilization has been associated with increased morbidity and death in the geriatric population in multiple studies (including this study), the posterior C1–2 transarticular screw fixation with modified Gallie fusion was a superior procedure, providing better internal fixation and allowing for earlier mobilization in a less restrictive brace.

The morbidity and mortality rates for the nonsurgical and surgical groups were similar; however, there was a higher rate of failure in the nonsurgical group. For those patients completing nonsurgical and surgical management, the clinical outcomes were similar, but the surgical group had a higher rate of stable fusion based on follow-up radiographic evaluation. The long-term outcome of a stable nonunion in the geriatric population may be adequate and needs to be further studied.

CONCLUSIONS

Type II odontoid fractures in this elderly population were associated with an in-hospital rates of 10% morbidity and 20% mortality. Nonsurgical treatment with a halo-thoracic vest or Minerva brace resulted in a 60% early failure rate (six of 10 patients) with 10% morbidity and 10% mortality rates, whereas surgical treatment was well tolerated, resulting in a 9% early failure rate (one of 11 patients) with 9% morbidity and 9% mortality rates. Posterior C1–2 transarticular screw fixation with modified Gallie fusion provided superior internal fixation and avoided the need for postoperative halo-thoracic vest or Minerva brace immobilization when the Type II odontoid fracture was not associated with other spinal fractures. Further study needs to be undertaken to investigate the role of less restrictive cervical orthoses and surgical intervention in the long-term outcome of Type II odontoid fractures in the geriatric population.

References